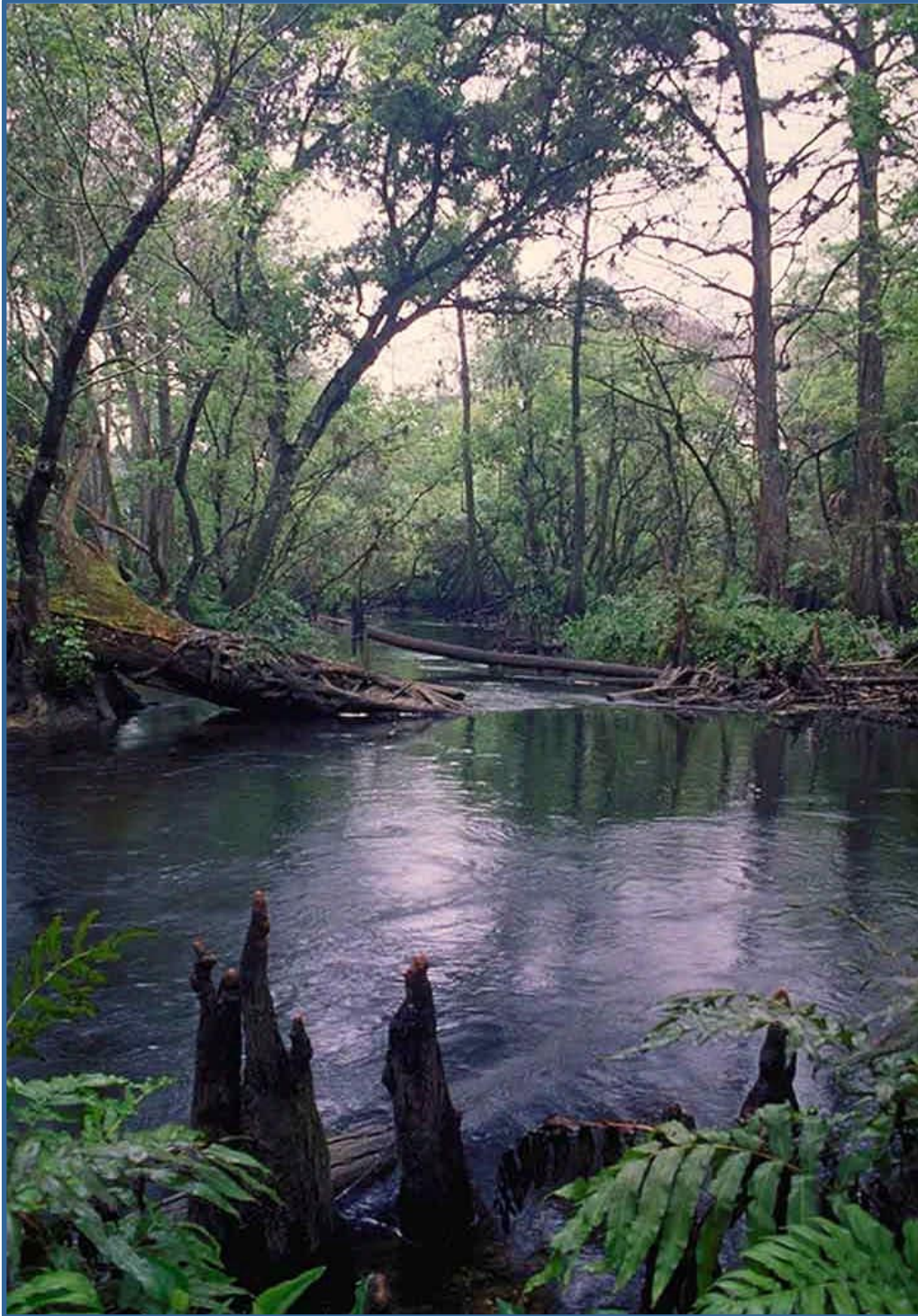


Northern Palm Beach County Comprehensive Water Management Plan Planning Document Volume I



**South Florida Water Management District
May 9, 2002**



sfwmd.gov

Northern Palm Beach County Comprehensive Water Management Plan

Planning Document (Volume I)



South Florida Water Management District

May 9, 2002

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EXECUTIVE SUMMARY

During the period from 1995-2001, the South Florida Water Management District (SFWMD) and the City of West Palm Beach led a cooperative effort to develop the Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP). The purpose of this effort was to develop a collective vision that would meet present and future water resource needs for the area.

A consensus-based process was used to develop this plan and evaluate alternative solutions that helped achieve this vision. Stakeholder participation on policy and technical advisory committees included representatives from public water supply utilities, water control districts, agricultural interests, environmental groups, and state and federal resource management agencies. The Policy Advisory Committee (PAC) identified planning assumptions and future conditions in the area. The Technical Advisory Committee (TAC) identified potential solutions and constraints. Both groups identified performance criteria that could be used to determine success.

Palm Beach County is expected to experience significant growth between now and 2020, primarily in the coastal areas. In the Northern Palm Beach County Planning Area, public water supply demands are projected to increase by 63 percent, from 82.2 million gallons per day (mgd) in 1995 to 128.6 mgd in 2020. No additional agricultural development is predicted to occur -- in fact, some existing agricultural lands may be displaced by future urban development. This planning area contains significant environmental resources that need to be maintained or enhanced, including the City of West Palm Beach's Grassy Waters Preserve, Palm Beach County's Loxahatchee Slough and the state of Florida's Northwest Fork of the Loxahatchee River. In addition, providing water for this basin in the future may potentially affect other nearby regional resources, including Lake Okeechobee, J.W. Corbett Wildlife Management Area, and the northern Everglades within the Water Conservation Area (WCA). Conclusions from the baseline runs of present and future conditions were that the current infrastructure was not adequate to meet future water management requirements.

To meet the projected future urban, agricultural and environmental demands, and protect water quality and environmental values, this plan identifies needs for the following infrastructure improvements:

- 48,000 acre-feet of storage in regional reservoirs
- 50 mgd of water storage in regional aquifer storage and recovery (ASR) facilities
- 12,000 acre-feet or more of additional storage in wetlands and local reservoirs
- 10 mgd or more obtained from reclaimed water

Additional structural features are needed to improve the ability to convey surface water among storage areas, control water levels in the Loxahatchee Slough and provide flow to the Northwest Fork of the Loxahatchee River.

The general goals of this effort were defined early in the process by the PAC -- to provide adequate water supplies to meet present and future, human and environmental needs, to protect water quality, to provide flood protection for urban and agricultural lands, and to protect and enhance important environmental resources. With assistance from the TAC, more specific objectives and the following concepts were developed to achieve these goals:

- **Capture surface water in the C-51 and L-8 basins that would otherwise be lost to tide.** Storage areas will be designed and operated to provide local flood protection, regional water supply and water quality benefits.
- **Link storage areas by improving existing canal systems and using newly constructed pumps and water control structures.** The backbone of the conveyance system would be the City of West Palm Beach's existing M-Canal, expanded to convey water to the City's surface water supply reservoir - the Grassy Waters Preserve.
- **Reconnect historical flows from Grassy Waters Preserve north into the C-18 Basin and the Loxahatchee Slough.** The Loxahatchee Slough, most of which has been acquired by Palm Beach County, is a wetland system that is in need of hydrologic restoration.
- **Augment baseflows to the Northwest Fork of the Loxahatchee River.** Improved flows are primarily achieved by providing additional storage capacity in, and water deliveries from, the Loxahatchee Slough.
- **Augment groundwater recharge for municipal wellfields in northern Palm Beach County.** Existing and proposed groundwater withdrawals in the C-18 Basin have been limited by virtue of wetland impacts in the Loxahatchee Slough. These impacts may be reduced or eliminated by construction of improved water delivery facilities and operational capabilities in the watershed.

The development and use of computer simulation models was critical to the success of the planning process. Specific water management features were combined to create water supply alternatives that were designed into the models. The models were run, based on historic climate conditions from 1985 to 1992, to produce simulated results. Each proposed alternative was carefully evaluated by agency staff and the advisory committees, using previously agreed-upon performance measures. The end product of this process was a recommended plan to increase the storage and conveyance of surface water within and between the respective basins, improve water quality, protect and enhance environmental resources and provide additional water for urban and agricultural use. These goals were achieved through a combination of improvements, including construction of new facilities, better management of existing water resources, and development of alternative water supply sources.

Preliminary results of the NPBCCWMP effort were provided as input during development of the Lower East Coast Regional Water Supply Plan (LECRWSP) by the

SFWMD. The modeling efforts undertaken by the SFWMD for the LECRWSP, as well as that undertaken in conjunction with the federal Comprehensive Everglades Restoration Plan (CERP), include conceptual elements in the northern Palm Beach County area. Additional planning and evaluation studies will be conducted in the future as LECRWSP and CERP projects move from conceptual to detailed design phases. These studies will provide a means to leverage state and federal support to better achieve the local and regional goals stated in this plan.

The federal effort to restore the Everglades through the CERP will, in the long-term, provide most of the infrastructure needed to make this NPBCCWMP plan succeed. The CERP projects will be implemented in two parts. Part I includes hydroperiod restoration in Pal-Mar and the Corbett Area, the C-51, C-17, and L-8 basins; and Lake Worth Lagoon restoration. These components will be implemented beginning in 2001 and be largely completed by 2010 at an estimated total cost of \$235 million. Part II includes construction of ASR facilities, and is scheduled to occur from 2009 to 2020. The estimated cost of Part II is \$ 188 million. The cost of these projects will be shared with the federal government. The federal process provides an opportunity to refine proposed projects and resolve issues to produce more effective solutions. To the extent that a consensus exists among local stakeholders and the United States Army Corps of Engineers (USACE), implementation of selected projects could be expedited to move forward during the next five years.

This action plan has been developed to address specific water resource issues in advance of CERP schedules in a manner that will be consistent with, facilitate, and expedite completion of CERP components. The projected schedule, funding, and local participation actions needed to implement and support the water resource development components of this plan through Fiscal Year (FY) 2005 are summarized in **Table ES-1**.

Table ES-1. The Projected Schedule, Funding, and Local Participation Actions Needed To Implement and Support the Water Resource Development Components of the Northern Palm Beach County Comprehensive Water Management Plan through Fiscal Year (FY) 2005.

| Project | Estimated Costs (\$ Millions) | | | | Finish Date | Long-Term Project Benefit | Partners (b) |
|--|-------------------------------|----------------|---------------|----------------|--------------|--|-----------------------|
| | Total | Local (a) | Through FY 02 | FY 03 to FY 05 | | | |
| L-8 Pilot Water Storage | \$.44 (c) | \$.44 | \$.44 | N/A (d) | 2001 | 3,500 acre-feet of storage | PBC, WPB, ITID, SFWMD |
| L-8 Reservoir Testing | \$3.1 | \$2.1 | \$2.1 | TBD | | demonstrate reservoir feasibility | PBC, SFWMD, USACE |
| C-2 Pump Station | \$4 | \$2 | \$0.5 (e) | \$3.5 | 2005 | 400 cubic feet per second (cfs) conveyance | WPB, ITID, SFWMD |
| M-Canal Widening | \$3 | \$1.6 | \$0.7 | \$1.4 | 2005 | 450 cfs conveyance | WPB, SFWMD, ITID |
| ASR Wellfield Pilot well const. Siting study | \$2.2 (f) \$.07 | \$1.1 \$.07 | \$0.4 | \$1.8 | 2004 | 1-5 mgd (pilot) up to 50 mgd | WPB, SFWMD |
| City of WPB Wetlands-Based Water Reclamation Project Phase 1 and 2 | 21.4 | 12.6 | 8.8 | N/A | 2003 | 15 mgd | SFWMD, WPB, USEPA |
| Flowway Improvement 3-72" Culverts G-161 Structure | .1 1.2 | .1 1.2 | .1 .1 | N/A 1.035 | 2002 2005 | 50 cfs (interim) 150 cfs conveyance | PBC, WPB, SFWMD |
| Lox Slough Structure (G-160) | \$2.5 | N/A | \$1 | (g) | 2006 | 5,000 ac-ft storage | PBC, SFWMD, Private |
| Total | \$38.01 | \$21.21 | \$14.20 | \$7.735 | | | |

Notes: (a) Local costs are assumed to be the non-federal funded portions of total costs, including combined SFWMD, local and other government contributions; (b) PBC = Palm Beach County, WPB = City of West Palm Beach, ITID = Indian Trails Improvement District, ECR = East Coast Regional Water Utility, Jupiter = Town of Jupiter Water Utility, ENCON = Loxahatchee River Environmental Control District, USEPA = United States Environmental Protection Agency, USACE = United States Army Corps of Engineers; (c) Pilot project through preliminary engineering design only; (d) dependent on final engineering design; (e) Through design and permitting phases only; (f) Feasibility and siting (1)-5 mgd pilot well only; (g) Construction administration.

Additional projects are underway, within and outside the planning area, that may affect and enhance the ability to achieve the goals and objectives of this plan. Work on, and results from, these efforts need to be considered and incorporated as this plan is implemented. These ancillary efforts include the following:

| | |
|---------------------------------------|-----------------------------------|
| Kitching Creek Study | West C-51 Project |
| C-17 Basin Study | Indirect Aquifer Recharge Study |
| Cypress Creek/Pal-Mar Watershed Study | Regional Reuse of Reclaimed Water |
| L-8 General Reevaluation Report | |

Preliminary results from the effort to develop minimum flow and level (MFL) criteria for the Northwest Fork of the Loxahatchee River were also considered during this analysis. Initial assumptions, based on information that was available at the onset of the planning process, were used as a basis to identify quantities of water and flow conditions that would protect the river's ecological resources from significant harm. The final versions of MFLs and restoration targets may recommend different flow conditions from those used in this plan. Once revised criteria have been developed, the MFL document will also include recovery and prevention strategies and identify any additional operational or structural features that may be needed to meet those criteria.

Other planning studies and projects are underway that have been initiated since this study was conducted, that will need to consider the conclusions and recommendations of this NPBCCWMP as input to their processes. Examples include the Palm Beach County Sector Plan; Hungryland Slough, Riverbend Park, and various other restoration projects; the Loxahatchee Slough Master Plan; and the Kitching Creek Comprehensive Basin Study that are underway by the City of West Palm Beach; Palm Beach, Martin and St. Lucie counties; Jonathan Dickinson State Park; and SFWMD.

The NPBCCWMP is contained in two volumes. Volume I details the schedules, costs, and funding of proposed projects for the next two to five years. Volume I also includes a list related water management projects and agencies involved in cooperative efforts that support or supplement this plan. Volume II is a technical report summarizing the planning, modeling and analyses that led to the recommended structural improvements.

This plan is designed to effectively address immediate problems, in a manner that is consistent with LECRWSP and CERP directions, to the extent that local, regional, and state support will allow. Proposed implementation schedules and cost estimates are provided and potential funding sources and project participants are identified. These recommended actions are not all inclusive, nor are they intended to limit the range of alternatives available to local governments or improvement districts in the management of water resources. Other local efforts and options for developing and managing water resources of northern Palm Beach County are underway and need to be supported as this plan is implemented. This plan also identifies areas of existing or potential conflict and unresolved resource management issues, which became apparent during the modeling studies and subsequent analyses. These concerns will be addressed in the next update of the LECRWSP, based on additional information and results of studies identified in this plan.

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LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|-----------------|--|
| ASR | Aquifer Storage and Recovery |
| ATV | All-Terrain Vehicle |
| AWT | Advanced Water Treatment |
| CDD | Community Development District |
| CDP | Criterion Decision Plus |
| CERP | Comprehensive Everglades Restoration Project |
| cfs | cubic feet per second |
| CWMP | Comprehensive Water Management Plan |
| DDM | Design Documentation Memorandum |
| DERM | Department of Environmental Resource Management |
| EAA | Everglades Agricultural Area |
| EIS | Environmental Impact Statement |
| ENCON | Loxahatchee River Environmental Control District |
| F.A.C. | Florida Administrative Code |
| FDEP | Florida Department of Environmental Protection |
| F.S. | Florida Statutes |
| FWC | Florida Fish and Wildlife Conservation Commission |
| FY | Fiscal Year |
| GDM | General Design Memorandum |
| GRR | General Re-evaluation Report |
| ITID | Indian Trail Improvement District |
| ITR | Independent Technical Review |
| LEC | Lower East Coast |
| LECRWSP | Lower East Coast Regional Water Supply Plan |
| LWDD | Lake Worth Drainage District |
| mgd | million gallons per day |
| MFL | Minimum Flows and Levels |
| MOA | Memorandum of Agreement |
| MOU | Memorandum of Understanding |
| MSL | Mean Sea Level |
| NPBCCWMP | Northern Palm Beach County Comprehensive Water Management Plan |
| NGVD | National Geodetic Vertical Datum |
| NPDES | National Pollution Discharge Elimination System |
| OPE | Other Project Elements |
| OPR | Operations Package |
| PAC | Policy Advisory Committee |

| | |
|---------------|---|
| PBA | Palm Beach Aggregate, Inc. |
| PIR | Project Implementation Report |
| PMP | Project Management Plan |
| POR | Period of Record |
| ppm | parts per million |
| ppt | parts per thousand |
| TAC | Technical Advisory Committee |
| SAS | Surficial Aquifer System |
| SFWMD | South Florida Water Management District |
| SIRWCD | South Indian River Water Control District |
| STA | Stormwater Treatment Area |
| USACE | United States Army Corps of Engineers |
| WCA | Water Catchment Area |
| WPB | West Palm Beach |
| WRDA | Water Resources Development Act |
| WTL | Wetlands Package |
| WTP | Wastewater Treatment Plant |

CONVERSION FACTORS

For the convenience of readers who may prefer to use metric units, rather than the inch-pound terms used in this report, values may be converted by using the following factors:

| <i>Multiply inch-pound unit</i> | <i>By</i> | <i>To obtain metric unit</i> |
|--|------------|------------------------------|
| <u>Length</u> | | |
| inch | 25.4 | millimeter |
| foot | 0.3048 | meter |
| mile | 1.609 | kilometer |
| <u>Area</u> | | |
| acre | 0.4047 | hectare |
| square foot | 0.0929 | square meter |
| square mile | 2.590 | square kilometer |
| <u>Volume</u> | | |
| gallon | 3.785 | liter |
| gallon | 0.003785 | cubic meter |
| cubic foot | 28.32 | liter |
| cubic foot | 0.02832 | cubic meter |
| million gallons | 3,785. | cubic meter |
| <u>Velocity</u> | | |
| feet per second | 0.6818 | mile per hour |
| feet per second | 1.097 | kilometer per hour |
| mile per hour | 1.4767 | feet per second |
| mile per hour | 0.4470 | meter per second |
| <u>Flow</u> | | |
| gallon per minute | 0.06309 | liter per second |
| gallon per minute | 0.00006309 | cubic meter per second |
| inch per year | 25.4 | cubic meter per second |
| cubic foot per second | 0.02832 | cubic meter per second |
| cubic foot per second | 28.32 | liter per second |
| cubic foot per second | 2,447. | cubic meter per day |
| <u>Hydrologic Information</u> | | |
| 1 cubic foot per second for 1 day | = | 1.98 acre-foot |
| 1 inch per hour of runoff from 1 acre | = | 1 cubic foot per second |
| 1 acre-foot | = | 325,851 gallons |

Chapter 1

INTRODUCTION

The Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP) was developed under the leadership of the South Florida Water Management District (SFWMD) and the City of West Palm Beach, with extensive participation and support from many other county and local government entities and private interests. The purpose of this effort since 1995 has been to address mutual goals for the management of water resources in the L-8, C-51, and C-18 canal basins in northern Palm Beach County. The surface water management system within this area serves a number of important, often competing functions, including the following:

- Directly supports the surface-water based potable water supply system for the City of West Palm Beach and its interconnected municipalities
- Indirectly supports the potable water supply systems for the Town of Jupiter, Seacoast Utility Authority, and the back up wellfield for the City of West Palm Beach through recharge of the surficial aquifer
- Represents the combined water supply and flood protection system for extensive agricultural operations and urban development
- Serves as the water supply and flood management system for wetland and aquatic ecosystems associated with the Grassy Waters Preserve, the Loxahatchee Slough, and the Northwest Fork of the Loxahatchee River

To meet present and future needs for management of water resources, two multidisciplinary advisory committees were established. These groups defined mutually agreed-upon goals and objectives, and performance measures that could be used to determine how well the goals and objectives were met. A number of potential resource management elements were proposed that could be used to meet existing and future water needs. The elements were combined together and analyzed using subregional hydrologic and water management models. Results of model simulations were evaluated by the committee and the most effective combinations were selected as components of this plan.

This plan was developed to identify these elements. The ability to meet future water needs of northern Palm Beach County relies heavily on the Comprehensive Everglades Restoration Plan (CERP), which was developed jointly by the United States Army Corps of Engineers (USACE) and the SFWMD (USACE and SFWMD, 1999), and the *Lower East Coast Regional Water Supply Plan* (LECRWSP) (SFWMD, 2000). These plans provide funding and technical support necessary to build and operate water resource development projects, major components of the regional infrastructure during the next 20 years. The costs, agency responsibilities, time schedules, and potential benefits associated

with completing those regional projects are described in this plan. Cooperation and assistance by state, regional, and local partners will also be required during the next five years to provide additional system features, land acquisition and resource management to fully achieve the goals and objectives of this plan.

PURPOSE OF THIS PLAN

The primary purpose of the NPBCCWMP is to document the planning process and technical analyses that were used to identify and select the recommended improvements that will meet present and future water needs of northern Palm Beach County. Success in attaining the water management goals of this plan depends on specific projects that are mostly structural, such as conveyance improvements and additional storage. Both the goals and selected projects of this subregional planning effort were coordinated with ongoing regional planning efforts. The technical analyses undertaken during development of the CERP and LECRWSP indicated that multiple water management goals could be achieved by using a selected set of storage and conveyance improvements in the study area.

The second purpose of this report is to identify the specific LECRWSP and CERP projects, costs, and schedules upon which the NPBCCWMP is dependent. Local partners may be asked to share some aspects of implementing these projects, provide funding for capital improvements, or assume operational and maintenance responsibilities. The SFWMD remains committed to the continued development of the CERP through the federal process and will, through a diligent outreach process, maintain local stakeholder participation. The federal process provides an opportunity to refine the proposed projects, resolve issues, and produce effective solutions. The down side of the federal process is the lengthy planning and implementation time required to complete each project. These extended time frames are due to a number of contributing factors, including mandatory Environmental Impact Statements (EISs) and the need to provide timely submittals of proposed construction plans to meet deadlines imposed by the biannual Water Resources Development Act.

This document also provides support to implement structural components that can be built and operated in advance of the CERP projects. Costs and funding strategies; schedules for design, permitting, and construction of facilities; and the need for operating and maintenance agreements and protocols are identified. To this end, the SFWMD has initiated certain preconstruction tasks, such as acting as local sponsor in applications for state and federal grant programs. A funding plan for these structural components is important to ensure that implementation will move forward in a timely manner.

An example of initiating a local effort to accelerate the schedule of a CERP component is the L-8 Reservoir Testing Project. This project is being financed at a cost of approximately \$3,100,000 by the Florida Department of Environmental Protection (FDEP), SFWMD, Palm Beach County, Indian Trail Improvement District (ITID) and the City of West Palm Beach to assess the feasibility of using rock pits that are owned by the Palm Beach Aggregates, Inc. (PBA) for water storage. At the request of, and with funding

from, local interests, the schedule for this activity was accelerated, in order to further the investigation for the L-8 Canal Basin General Re-evaluation Report and formulation of the CERP project implementation report (PIR) and to provide "interim benefits" to water supply, flood protection, and the environment.

At the conclusion of the initial phase of the L-8 Pilot Water Storage project (see Local Option Projects section), the parties agreed that additional testing was required to assess water quality and site feasibility. The L-8 Reservoir Testing will continue for three years, and has been expanded to include an additional pit. The available storage is currently 170 acres with an operational depth of up to 35 feet providing a total storage of about 6,000 acre-feet. The project involves construction of intake facilities during 2001, additional water quality monitoring (inflow, within pits, and outflow), determination of optimum water levels and drawdown duration, and monitoring of naturally-occurring radioactive elements.

Finally, the technical analyses indicate a potential for detrimental impacts that are likely to occur to regional water resources until the proposed projects are completed. Based on this information, this document identifies projects that can, and should be, accelerated in order to achieve benefits sooner and reduce potential detrimental resource impacts. To the extent that a consensus exists among local stakeholders, the SFWMD and the USACE, implementation of some projects can proceed immediately.

BASIS OF WATER SUPPLY PLANNING

The Florida legislature has delegated authority to the SFWMD to protect South Florida's water supply by managing water use at the regional level to meet future demands. Beginning in the 1990s, the SFWMD initiated water supply planning efforts to ensure prudent management of South Florida's water resources. This effort began with the development of a *District Water Supply Policy Document* (SFWMD, 1991), and continued with the *District Water Management Plan* (SFWMD, 1995, 2000), *District Water Supply Assessment* (SFWMD, 1998), and regional water supply plans such as the LECRWSP (SFWMD, 2000).

The SFWMD's water supply plans are guided by directives and policies embodied in the *District Water Supply Policy Document* (SFWMD, 1991), Water Resource Implementation Rule (Chapter 62-40, F.A.C.), Chapter 373, F.S., the State Comprehensive Plan (Chapter 187, F.S.), and delegation of authority from FDEP. In addition, water supply plans must meet the requirements of the 1996 Governor's Executive Order (96-297) and 1997 legislative water supply amendments to Chapter 373, F.S. to include the following:

- A 20-year planning horizon
- A quantification of estimated water supply needs
- A list of water source options for water supply development which will exceed the identified needs

- For each water source option, the estimated amount of water available and the estimated costs
- A list of water supply development projects that meet the criteria in Section 373.0831(4)
- A list of those water resource development projects that support water supply development
- For each water resource development project listed, provide the following information:
 1. An estimate of the amount of water to become available
 2. The timetable and the estimated costs
 3. Sources of funding and funding needs
 4. Who will implement the project and how it will be implemented
 5. A funding strategy
 6. Consideration of how the options serve the public interest or save overall costs
 7. Technical data and information
 8. Minimum flows and levels and associated recovery and prevention strategies established within the planning region (Section 373.042(1))

For this northern Palm Beach County region, minimum flows and levels and associated recovery and prevention strategies are being established within the planning region by a separate planning process that will be incorporated into a technical document in conjunction with rule development.

The LECRWSP (SFWMD, 2000), which includes Palm Beach County, was completed by the SFWMD in May 2000, and indicated that a more detailed, subregional planning effort was underway for northern Palm Beach County to address local water resource issues and concerns. Preliminary results from this northern Palm Beach County planning effort were incorporated into the LECRWSP. Those results were further refined and are provided in this NPBCCWMP for use by the SFWMD, other agencies and local interests.

AGENCY AND PUBLIC PARTICIPATION

Two advisory committees were created to oversee development of the NPBCCWMP. A Technical Advisory Committee (TAC) included scientists, engineers and other experts. The Policy Advisory Committee (PAC) included representatives from water supply utilities, water control districts, agricultural interests, environmental groups, and related state and federal resource management agencies. These committees met

periodically to provide guidance, direction, and technical support throughout the planning process. A list of committee members is included in **Appendix A** of the Technical Support Document, Volume II.

In addition, a number of public meetings were held, and periodic updates were provided to local utilities, agencies and interest groups to describe progress of the planning efforts. Information concerning this plan was also presented periodically at SFWMD Governing Board meetings and workshops to solicit public comment and input.

GOALS AND OBJECTIVES

The advisory committees identified the primary, often competing water resource functions (described above) of the northern Palm Beach County water supply system. Water resources must be effectively managed to serve these functions. The committees also determined that significant growth and land development are expected to occur within the planning area during the next 20 years. As indicators, population is expected to increase by 50 percent and public water supply demands are projected to increase by 63 percent.

The original goals of this cooperative effort, as identified by the advisory committees, are to enhance water supply, water quality, flood protection and environmental resources within northern Palm Beach County during the next 20 years. To achieve these goals, specific and quantifiable objectives were identified. These water resource management objectives for the area evolved through numerous discussions among the stakeholders and are summarized as follows:

- Provide supplemental water to the Loxahatchee Slough sufficient to maintain water levels such that they do not fall below the target hydroperiod by more than 6 inches during normal years, and for no more than 30 days during droughts with a return frequency of up to ten years. The target hydroperiod is described in the Technical Support Document (see Figure 7, Volume II).
- Provide supplemental water to maintain a flow of up to 65 cubic feet per second (cfs) over the Lainhart Dam to maintain appropriate bottom salinities in the Northwest Fork of the Loxahatchee River.
- Improve the timing and volume of flow provided from other tributaries to the Northwest Fork of the Loxahatchee River. Improved flow from other sources will reduce the amount of supplemental water that is needed from the C-18 Basin (delivered through G-92 and subsequently over the Lainhart Dam) and the regional system. Improving flow from other tributaries will most likely require additional storage within those basins.
- Provide 5 cfs of baseflow to the Southwest Fork of the Loxahatchee River.

- Allow periodic historical flow from C-18 Canal to wetlands located within the Mirasol Project (formerly known as Golf Digest).
- Provide sufficient recharge within the Town of Jupiter to prevent saltwater intrusion into their wellfield.
- Provide sufficient water to maintain the Grassy Waters Preserve at levels desirable for native plant communities and snail kite populations while preventing damage to Northlake Boulevard.
- Provide a dependable public water supply through 2020 for the utilities in the region for a drought with a return frequency of 1-in-10 years, to be consistent with water supply plans.
- Identify alternative sources and quantities of water that will enable public water supply utilities to meet drought demands and/or minimize drought restrictions. Such alternative sources include aquifer storage and recovery (ASR) and the reuse of reclaimed water.
- Continue to meet basinwide agricultural water supply needs including the ability to provide an average annual volume of 4.6 (million gallons per day) mgd from surface water sources for agricultural water supply to Callery Judge Grove.
- Assist the Indian Trail Improvement District (ITID) with peak flow management to provide additional flood protection.

COORDINATION WITH OTHER EFFORTS

As mentioned above, this local planning effort was closely coordinated with the development of the LECRWSP by the SFWMD. The modeling undertaken by the SFWMD for the LECRWSP, as well as that undertaken in conjunction with the federal CERP, affirmed the conceptual plan for the area. Based on this affirmation, the CERP intends to conduct additional planning and evaluation in the future, with further refinement of the recommendations. In addition to the USACE and SFWMD, other partners and activities must play a critical role to ensure the success of this planning effort. Therefore, the plan includes a list of related CERP projects and a discussion of participation that is needed by other partners and efforts.

As a final note, the recommendations resulting from the technical analyses conducted as part of this planning effort are not all inclusive, nor are they intended to limit the range of alternatives available to local governments or improvement districts. Local options for managing the water resources of northern Palm Beach County are evolving and deserve consideration. For this purpose, a list of related water management projects and the water management agencies involved is also provided.

STRUCTURE OF THIS REPORT

The NPBCCWMP is contained in two volumes. Volume I details the overall scope of the plan and the features, schedules, costs, and funding of proposed projects for the next two to five years, prior to the implementation of CERP projects in the area. The Technical Support Document, Volume II, provides a summary of the technical tools, assumptions, planning activities, and analyses that led to the proposed recommendations.

The federal effort to restore the Everglades via the CERP will, in the long-term, incorporate and further refine the recommendations in this report. This is an action plan, which was developed to address specific water resource issues and supplemental activities that are needed, in the interim, to provide necessary links between regional facilities created by the CERP and local needs. The actions described in this plan are intended to address both immediate and long-term problems in a manner that is as consistent as practicable with the proposed CERP direction, and to the extent that federal, state, regional, and local funding allows. Proposed implementation schedules, cost estimates, and funding agreements are identified based on the best available information.

Chapter 2

AREA DESCRIPTION AND RESOURCES

LOCATION AND FEATURES

The Northern Palm Beach County Planning Area (**Figure 1**) encompasses parts of five major surface water basins. These include the C-51, C-18, and L-8 canal basins, the City of West Palm Beach Grassy Waters Preserve, and the southern portion of the South Indian River Water Control District (SIRWCD). This area contains a mixture of residential, agricultural, and natural or undeveloped land uses. Three additional basins (the C-17 Canal Basin, eastern C-51 Basin, and Intracoastal Basin) lie to the east of the planning area and consist largely of urban, and commercial land uses. The planning area covers just under 200 square miles (approximately 115,000 acres). Historically, much of this landscape was covered with wetland marshes and swamps and flood-tolerant upland species such as pines and palmettos. Due to the flat, low-lying topography and relatively limited access to the sea, much of this area is poorly drained and prone to flooding.

The C-51 Canal Basin in central Palm Beach County is divided into eastern and western subbasins. The western subbasin consists primarily of residential and agricultural land uses. The eastern basin has urban, commercial and industrial uses including an international airport. Drainage from this basin discharges to tide through the C-51 Canal and the S-155 Structure into Lake Worth Lagoon.

The C-18 Canal Basin lies in northeastern Palm Beach County and includes residential and agricultural land uses as well as large tracts of natural wetlands in Loxahatchee Slough. Water from this basin drains northward to the Loxahatchee River.

The L-8 Canal Basin lies to the west of the C-18 and C-51 basins and east of the Everglades Agricultural Area (EAA). Most of the northern part of this basin is undeveloped wetlands and uplands in the J.W. Corbett Wildlife Management Area. The southern and eastern portions of the basin contain agricultural and low-density residential land uses. This basin drains primarily to the south into the western end of C-51 Canal.

The Grassy Waters Preserve is a large tract of wetlands that is owned and maintained by the City of West Palm Beach and serves as a surface water storage reservoir for public water supply. Water from this wetland is discharged to the east through the M-Canal to Lake Mangonia and Clear Lake, and subsequently enters the City's water treatment plant in West Palm Beach. Originally the Grassy Waters Preserve wetlands were connected through the C-51 Basin to the Everglades to the south. During very wet periods, water may have flowed from the Everglades to the Northwest Fork of the Loxahatchee River. General lowering of water levels due to drainage and construction of canals, levees and roads have significantly altered the hydrology of this basin. In the 1950s and 1960s, the Central and Southern Florida Flood Control Project compartmentalized the major wetlands and channeled flows through major canals toward the Lake Worth Lagoon. Today, the C-18 Basin is isolated from the larger Kissimmee-

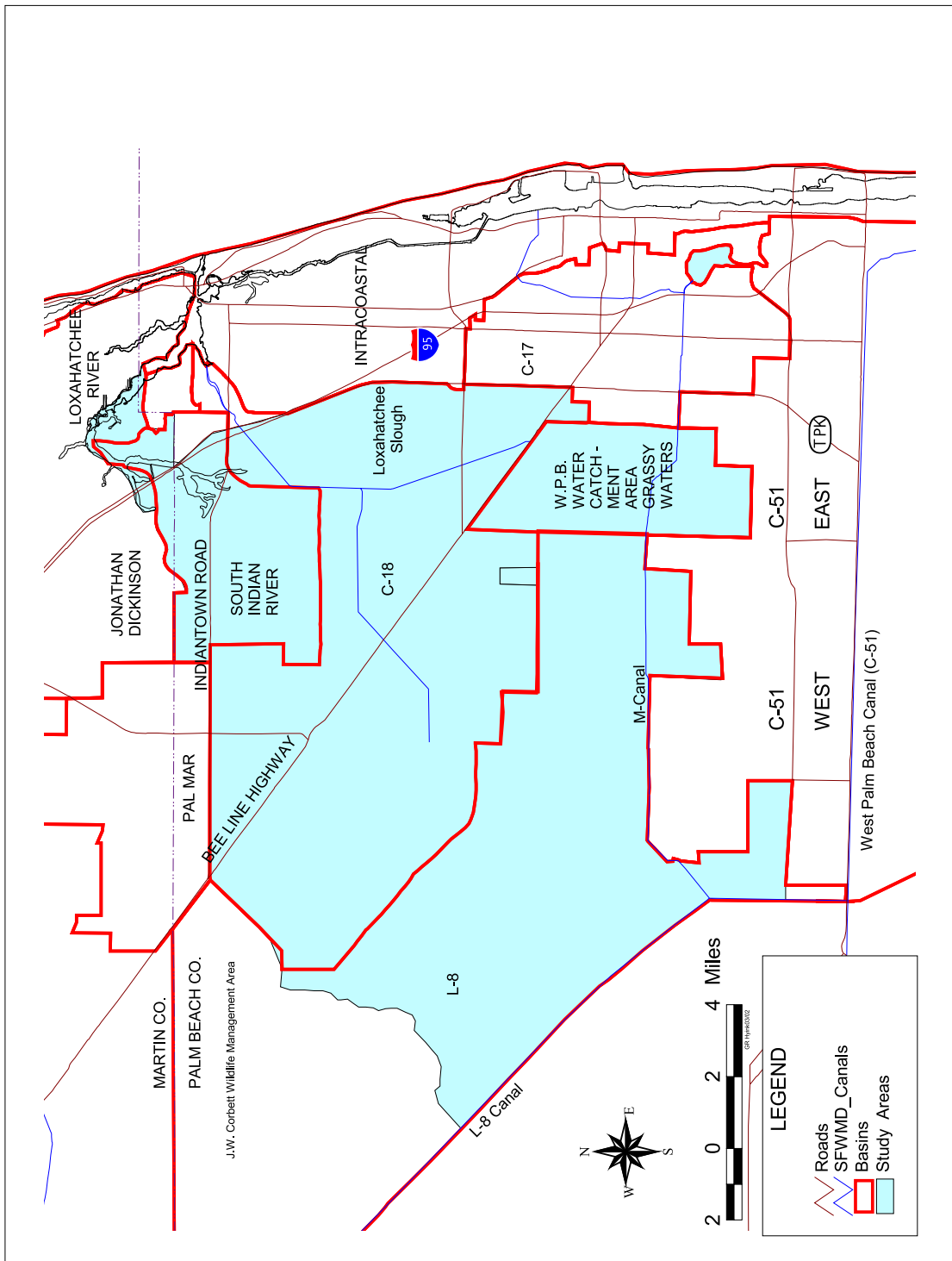


Figure 1. Locations and Boundaries of Hydrologic Subbasins in Northern Palm Beach County.

Okeechobee-Everglades hydrologic system. The Grassy Waters Preserve, located in the C-51 Canal Basin, receives water primarily from local rainfall; however, additional water can be delivered from Lake Okeechobee through the L-8 Canal and M-Canal.

Population, land development, and water use in the C-18 and C-51 basins have intensified rapidly during the past fifty years, resulting in loss of the natural water holding capacity of the land and increased competition for available water supplies within these basins. Water management issues associated with the Kissimmee-Okeechobee-Everglades region have further complicated the local management of surface water in the area. The need to provide more water for Everglades restoration has resulted in proposals to divert water from the L-8 Basin into Lake Okeechobee and the Everglades, thereby potentially removing water that might otherwise be available for use in the C-18 and C-51 basins. These actions stimulated local interests to work together to achieve common resource protection and management goals for the northern Palm Beach County area.

Palm Beach County is expected to experience significant growth between now and 2020, primarily in coastal areas. In the Northern Palm Beach County Planning Area, public water supply demands are projected to increase by 62 percent, from 82 mgd in 1995 to 128.6 million gallons per day (mgd) in 2020. In contrast, Palm Beach County agricultural water demands (excluding the EAA, which is located in western Palm Beach County, outside of the planning area) are projected to decrease 12 percent by 2020. Agricultural land use in northern Palm Beach County presently consists of approximately 4,000 acres of citrus, 1,600 acres of vegetables and 1,600 acres of pasture and turf. The total average annual demands are estimated as 7 mgd for citrus, 2 mgd for vegetables and 4 mgd for pasture and turf. No significant additional agricultural development is predicted to occur in northern Palm Beach County and large tracts of agricultural lands may be displaced in the future by urban development.

HISTORY

The following brief history is useful in understanding how this plan originated:

- The western C-51 Basin and southern L-8 Basin have historically had less than 1-in-10 year levels of flood protection due to lack of conveyance capacity in the C-51 Canal.
- Long-term sensitivity of the Everglades ecosystem to even low level nutrients precluded backpumping of C-51 waters to the Water Conservation Areas (WCAs). Backpumping into the WCAs requires substantial water quality pretreatment which adds considerable cost and makes backpumping less desirable as a solution to drainage in these flood-prone areas.
- Estuarine impacts created by high flows and poor water quality from C-51 Canal to the Lake Worth Lagoon have forced water managers to seek solutions other than discharge to tide through the C-51 Canal and S-155 to solve the problem of flooding in the western basins.

- Drainage of the C-18 Basin, the lack of a connection to the regional water management system, and construction of the Jupiter Inlet have contributed to a reduction in baseflow, and increased exchange with the ocean. These changes have caused saltwater intrusion to move further upstream in the Northwest Fork of the Loxahatchee River, a federally-designated Wild and Scenic River.
- The Everglades Protection Project (Burns and McDonnell, 1993, 1994) resulted in a reduction of the availability of regional water to water users in eastern Palm Beach County. This project proposed diverting water from the northern L-8 Basin into Lake Okeechobee to make up for additional evaporative losses associated with the stormwater treatment areas (STAs) in the Everglades Protection Area
- Continued drainage and development of the region's natural areas continues to reduce water storage and ground water recharge for traditional sources of public and agricultural water supply.

NEED FOR IMPROVEMENT

As a consequence of the historical events listed above, a consensus was reached among federal, state, regional and local water managers in the 1990's to move forward with a conceptual plan to impound surface water in three storage areas in the C-51 and L-8 basins. These storage areas would be linked together through existing canal systems and newly constructed pumps and water control structures. The backbone of the conveyance system would be the City of West Palm Beach's existing M-Canal, expanded to convey water to the Grassy Waters Preserve that is also a potable water supply source for the City of West Palm Beach.

Water in the vicinity of the Grassy Waters Preserve historically flowed north towards the Loxahatchee Slough during wet periods. However, flow barriers created by the berms associated with the preserve itself, the construction of Northlake Boulevard, and increased water demands by the City of West Palm Beach have reduced flow from the preserve to the Loxahatchee Slough and Loxahatchee River. The ability to enhance hydrologic conditions in the slough and river depends in part on moving additional water to and through the preserve.

The C-18 Basin, including the Loxahatchee Slough and contributions from the J.W. Corbett Wildlife Management Area, is a significant source of surface water flow to the Loxahatchee River and a minor source of water for ground water recharge to municipal wellfields in northern Palm Beach County. The Northwest Fork of the Loxahatchee River, a national Wild and Scenic River, has been impacted by both structural changes and drainage and development activities within the basin. Structural changes include dredging of the Jupiter Inlet (1947) and construction of the C-18 Canal (1950s). These changes have resulted in the substantial mortality of cypress trees and

upstream encroachment by mangroves within the lower portions of the river, downstream of river mile 8. There is less severe mortality in the central portions of the river, between river miles 8 and 12, where groundwater flows may protect cypress within, adjacent, and slightly away from the river's edge.

The exact nature and extent of the effects of saltwater intrusion on cypress habitat in the central portion of the river are difficult to assess due to several complicating factors. First, the remaining cypress trees are robust and may take several years before the effects of adverse conditions become visible. Second, flow conditions in the river vary considerably from year to year due to changes in rainfall. In addition, the threshold concentrations of salinity required to cause stress to, or kill, an individual cypress tree or seedling, have not been clearly defined.

By comparison, the cypress forest of the more saline lower portions of the Northwest Fork of the Loxahatchee River has died back during the past fifty years and been replaced by mangrove swamp. Existing and proposed water supply withdrawals in the C-18 Basin have therefore been modified through South Florida Water Management District (SFWMD) permits in an attempt to minimize further wetland impacts in the Loxahatchee Slough and Northwest Fork of the Loxahatchee River.

VISION OF WHAT IS NEEDED

The long-term vision is to hydrologically restore the Loxahatchee Slough so that it can support natural wetland plant and animal communities, provide a source of groundwater recharge for local water supply needs, and provide a source of supplemental water that can be delivered to the Northwest Fork of the Loxahatchee River. To successfully meet these management objectives, new or improved structural facilities and operational procedures must be provided to capture local runoff and convey more water into the slough. The need for a connection to the regional system through Grassy Waters Preserve is also identified as a critical requirement of the Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP).

In addition to hydrologic restoration, control of exotic vegetation is of concern in the Loxahatchee Slough. Central wetland portions of the slough are infested with exotics (e.g., melaleuca and *Lygodium* sp.). Vegetation mapping by Erwin (1992) indicated that 645 acres or 12.4 percent of the central wetland portions of the slough were predominantly exotic vegetation.

This vision has been the impetus behind a commitment by the City of West Palm Beach to help formulate a sound, long-term subregional plan that optimizes surface water management for water supply, flood protection, and ecosystem management purposes. Since 1995, the SFWMD and the City of West Palm Beach have cooperatively funded this planning process and focused on developing a conceptual plan that identifies the needs of this unique area and the structural and operational improvements necessary to meet these needs. Computer models were developed to evaluate the relative benefits provided by each identified water management alternative. The identified needs and improvements

were communicated to both the Comprehensive Everglades Restoration Plan (CERP) and the Lower East Coast Regional Water Supply Plan (LECRWSP) and integrated into these planning processes.

Chapter 3

THE PROCESS

With direction from the advisory committees, computer models were developed to evaluate the ability of alternatives (combinations of existing or proposed infrastructure features) to meet the goals and objectives of this plan. The primary analytical tools developed for screening of water management alternatives were three water balance or water budget models for locations within the planning area.

ANALYTICAL TOOLS

- The Southern L-8 Basin Model includes an area of approximately 56 square miles (36,000 acres) and has 13 subbasins. Key surface water features in this model include the southern reach of L-8 Canal (south of the proposed site for the S-316 Water Control Structure) and the M-Canal leading to Grassy Waters Preserve.
- The Water Catchment Area (Grassy Waters Preserve) Model covers an area of approximately 19 square miles (11,000 acres) and includes 2 subbasins. Key surface water features of this model include the M-Canal, Grassy Waters Preserve, and the City of West Palm Beach's water supply lakes
- The Loxahatchee Slough Basin Model covers an area of 117 square miles (75,000 acres) and includes 32 subbasins. Key surface water features are the Loxahatchee Slough, C-18 Canal, C-18 West Canal; and C-14 Canal that connect to the Northwest and Southwest Forks of the Loxahatchee River.

Boundaries of the areas included in each model are shown in **Figure 2**. Hydraulic models were also developed for potential application to analyze conveyance needs for proposed system changes. These models are discussed in detail in the Technical Support Document, Volume II.

MODELING ASSUMPTIONS AND CRITERIA

The Technical Advisory Committee (TAC) approved the modeling assumptions and criteria for success. These assumptions and criteria include reaching technical agreement on, and definition of, specific performance measures for the following issues:

- Loxahatchee Slough - define the volume of water needed to meet hydroperiod restoration targets for the slough, maintain baseflows to the Northwest Fork of the Loxahatchee River, and maintain or improve water supply and flood protection service.

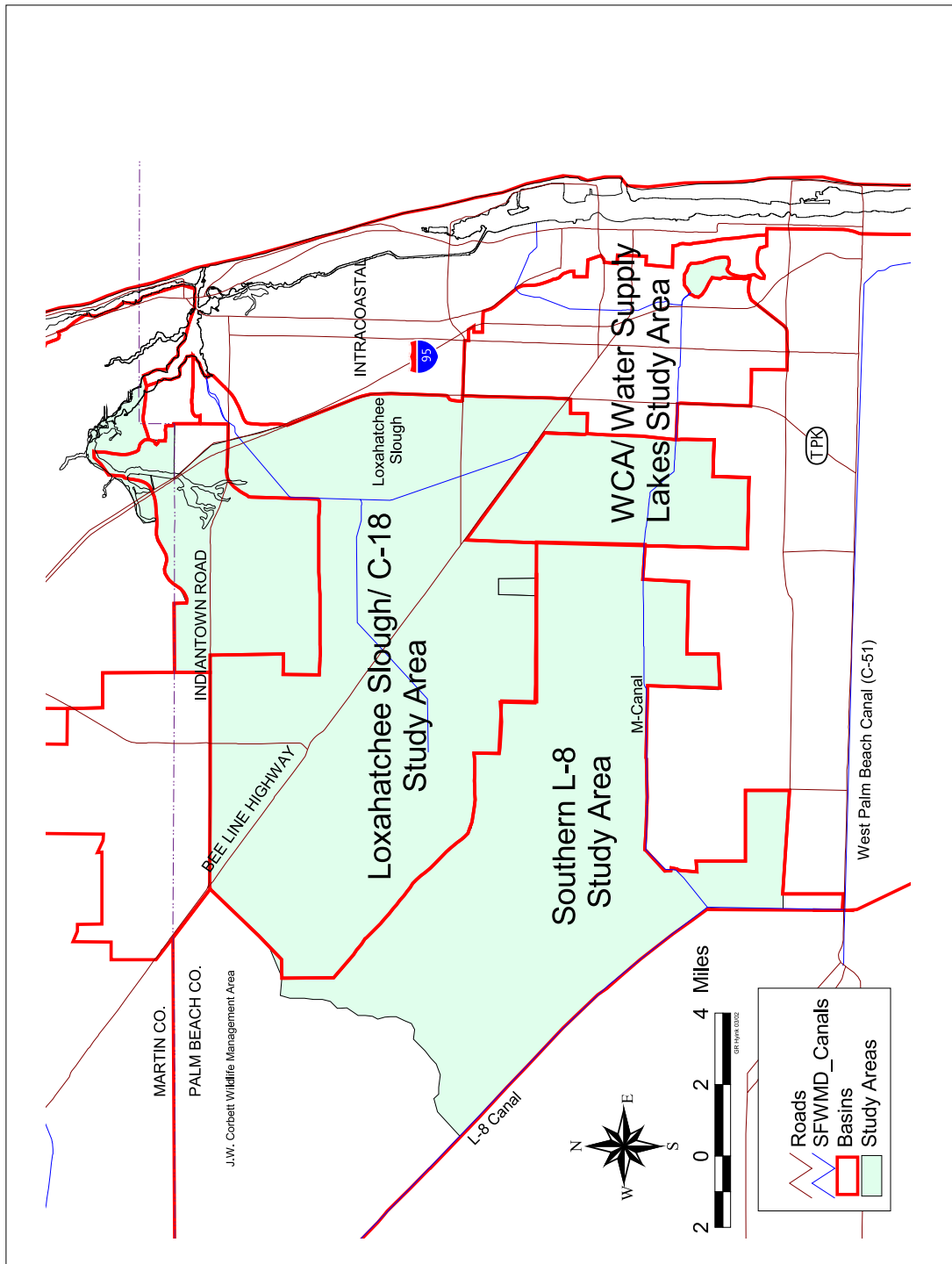


Figure 2. Boundaries of the Northern Palm Beach Subregional Model Study Areas.

- Grassy Waters Preserve - identify the volume of water needed to meet the preserve hydroperiod management targets, and estimated 2020 potable and irrigation water supply demands.
- Southern L-8 Basin - determine the reservoir storage volume required to meet water supply demands in the Grassy Waters Preserve and Loxahatchee Slough basins, or potentially other downstream basins, and confirm that there is sufficient runoff available from the L-8 Basin to fill such a reservoir.

DEVELOPMENT OF ALTERNATIVES

The South Florida Water Management District (SFWMD) and the City of West Palm Beach led the effort to develop a series of water management alternatives for each of the study subareas, with facilitated input from the stakeholder group (Policy Advisory Committee (PAC)), as described in Volume II. The PAC members participated in a series of work group meetings to help identify and screen alternatives for each basin. These workshops were designed to solicit input on candidate alternatives, and help identify criteria that would be used to prioritize alternatives to be evaluated with the modeling tools. Through this participatory process, alternative solutions were developed to achieve the plan objectives.

PERFORMANCE MEASURES

Performance measures were developed as a means to determine how well the goals and objectives of the plan were met during each model simulation. Performance measures were incorporated into each model to assess the benefits of conceptual alternatives and/or compare each modeling simulation. The PAC members suggested adding performance measures to facilitate the comparison of several model simulations at one time. The performance measures added to each of the models incorporated input from the PAC members. Some examples of performance measures are described below.

One of the performance measures for the southern L-8 Basin involved reducing the peak discharges and annual volume discharged to the C-51 Canal and, subsequently, to the Lake Worth Lagoon. This performance measure is presented as a summary table that shows the number of days per year that the discharge to the C-51 is above or below target levels (e.g., see **Table 13** in Volume II, the Technical Support Document).

For the Grassy Waters Preserve model, performance measures were added to track marsh water levels. One format consists of a stage duration curve that shows the percent of time at which a particular stage occurs within the period of record (e.g., **Figure 17**, Volume II). Stages in the Grassy Waters Preserve were also tabulated to determine the number of days they exceeded a selected maximum level or fell below a minimum level (e.g., see **Table 14** in Volume II).

Performance measures were also established for stages in the Loxahatchee Slough (**Figure 27** in Volume II) and for flows discharged to the Northwest and Southwest Forks of the Loxahatchee River (**Tables 16** and **17** and **Figure 36** in Volume II). The stage-versus-time hydrograph for the Loxahatchee Slough was used to compare the target hydroperiod with results of the modeling simulation.

EVALUATION OF ALTERNATIVES

A consensus-based process was used to evaluate each proposed water supply alternative in terms of the ability to meet identified performance measures and the goals and objectives of the Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP). The development and use of models were critical to the success of this process, since these tools allowed each proposed alternative to be carefully and consistently tested for performance within agreed-upon parameters. Details of the scenarios evaluated, and the ability to meet performance measures under the various simulations are provided in the Technical Support Document, Volume II.

DEVELOPMENT OF RECOMMENDATIONS

Preliminary model results and recommendations were presented to the PAC at a meeting in January 1998. Based on discussions and questions raised at this meeting, additional modeling was undertaken and presented to the committee in September 2000. Responses to the discussions and issues raised at that final advisory committee meeting are included in **Appendix B** of Volume II. The result of these efforts was the development of a recommended program of structural improvements that would meet the goals and objectives of the plan by increasing the storage and conveyance of surface water within and between the respective basins, as well as through development of alternative water supply sources.

Chapter 4

SOLUTION DEVELOPMENT

STORAGE AND CONVEYANCE IMPROVEMENTS NECESSARY TO MEET GOALS

The Policy Advisory Committee (PAC) for the Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP) identified a large number of project elements that could be used in different combinations to create many different modeling scenarios. Performance of each scenario and its component elements towards achieving the planning goals and objectives was evaluated through use of the models. A complete list of elements is included in **Table 1**. Of the more than 40 elements proposed, the following were determined by the PAC to be most successful toward achieving the goals and objectives of this plan. Further descriptions of modeling assumptions, and the design and operation of these improvements are provided in the Technical Support Document, Volume II.

- Provide 48,000 acre-feet of storage in a single or multiple reservoirs located in either the Southern L-8 Basin or the Southern L-8 and C-18 basins.
- Provide 50 million gallons per day (mgd) of aquifer storage and recovery (ASR) capacity.
- Increase the pumping capacity from the L-8 Canal into the M-Canal up to 300 cubic feet per second (cfs).
- Increase the conveyance capacity of the M-Canal up to 450 cfs.
- Provide additional wastewater reuse of 10 mgd.
- Provide up to 150 cfs of conveyance capacity from the regional system to the C-18 Basin. One of the identified routes for this connection was through the Grassy Waters Preserve. Major constraints on delivery of water by this route are the presence of Northlake Boulevard and the need to avoid excessive water levels in the Grassy Waters Preserve. The proposed facility and appurtenant works needed to convey water under Northlake Boulevard are referred to as the "G-161 Structure" to be consistent in nomenclature used for other nonfederal, South Florida Water Management District (SFWMD) structures.
- Backpump from tributaries of the C-17 Canal into a 550-acre stormwater treatment area (STA), which subsequently discharges to the Grassy Waters Preserve.
- Construct a structure in the Loxahatchee Slough that is capable of providing more precisely controlled and measured discharges of 0-100 cfs, less precisely controlled discharges from 100 to 500

Table 1. List of Alternatives by Basin

| | |
|--|--|
| Southern L-8 Basin | |
| Conveyance Changes within the Subarea | |
| M-Canal Expansion | |
| New West Palm Beach Control 2 (Existing Site or Moved East) | |
| Storage Mechanisms | |
| Palm Beach Aggregate Surface Water Reservoir | |
| ASR wells | |
| Stormwater Treatment Area (STA) in Section 1 just west of the Grassy Waters Preserve | |
| Convert Indian Trail Improvement District (ITID) Impoundment to a STA | |
| Expanded capacity of ITID's Impoundment | |
| Conveyance Out of the Study Subarea | |
| Diversions to west leg of C-18 | |
| Diversions to Lake Worth Drainage District (LWDD) via C-51 | |
| Diversions to tide via C-51 | |
| Additional Features | |
| The redirection of flows from ITID's impoundment through a new conveyance canal directly south to the L-8 Canal would allow removal of existing canal/levees and allow restoration of sheet flow from the J.W. Corbett Wildlife Refuge south toward the L-8 Canal. | |
| Grassy Waters Preserve/Water Supply Lakes | |
| Conveyance of Water Into the Subarea | |
| New West Palm Beach Control 2 (Pump Station) | |
| Input of high quality, Advanced Wastewater Treatment (AWT) Reuse Water | |
| Diversions from C-17 Basin | |
| Conveyance Within the Subarea | |
| M-Canal Expansion | |
| New West Palm Beach Control 3 | |
| New West Palm Beach Control 4 | |
| Storage Mechanisms | |
| Revise Grassy Waters Preserve Regulation Stage | |
| Increase Functional Grassy Waters Preserve Footprint (Alternative Sites 1 and/or 2) | |
| Aquifer Storage and Recovery (ASR) wells | |
| Conveyance Out of the Subarea | |
| Increased Flow to C-18/Loxahatchee Slough under Beeline (operational schedule) | |
| Increase Water Treatment Plant Withdrawals | |
| Diversions to C-17 (tide) | |
| Diversions to C-51 (tide) | |
| Diversions to LWDD via C-51 | |
| Loxahatchee Slough Basin | |
| Conveyance Into the Study Subarea | |
| Diversions (pump) from C-14 to C-18 from South Indian River Water Control District (SIRWCD) | |
| Diversions to C-18 (Loxahatchee Slough) from the Grassy Waters Preserve | |
| Diversions to west leg of C-18 from L-8 Basin (ITID) | |
| Diversions to west leg of C-18 from L-8 Basin (Corbett) | |
| Diversions to Slough National Area from SIRWCD | |
| Conveyance within the Study Subarea | |
| New C-18 Structure | |
| Turnpike Ditch Structure | |
| Caloosa Water Control Structure/System | |
| Siphon Under west leg of C-18 | |
| Increased C-18 Conveyance/Modify All Affected Structures | |
| Storage Mechanisms | |
| Raise Loxahatchee Slough Stage to Meet Restoration Hydroperiod | |
| Reservoir along west leg of C-18 | |
| Aquifer Storage and Recovery (ASR) | |
| C-18 Canal Stage | |
| Conveyance Out of the Study Subarea | |
| Establish Minimum Flow and Level Criteria for G-92 to the Northwest Fork | |
| Target Flow for S-46 to Southwest Fork | |
| Jupiter Wellfield Recharge Canal | |
| Seacoast (Hood Road) Wellfield Recharge System | |
| Back Flow/Pump to Grassy Waters Preserve | |

cfs, and a maximum discharge of 1,100 cfs. This proposed structure and appurtenant works is termed "G-160", to be consistent in nomenclature with other nonfederal, SFWMD structures.

- Install conveyance improvements to provide additional recharge in an area susceptible to saltwater intrusion within the Town of Jupiter.
- Reroute excess surface water runoff from Old Marsh and East Point into the Mirasol stormwater system to provide groundwater recharge, water quality enhancement, and maintain lakes and wetlands, before discharge into the Loxahatchee Slough, east of C-18 Canal.

LOXAHATCHEE RIVER MINIMUM FLOWS AND LEVELS

The SFWMD is statutorily charged (Section 373.0420 F.S.) with the responsibility to define and prevent "significant harm", by establishing minimum flow and level (MFL) criteria for priority water bodies within its jurisdiction. The process of prioritizing water bodies and establishing MFL rules is governed by administrative rules that ensure due process. The Northwest Fork of the Loxahatchee River was originally designated for MFL development by December 2001 under this process. Draft numeric criteria were developed in May 2001 and were peer reviewed by a panel of experts during June 2001. Based on the results of this review and other comments received, the technical document, and the criteria, are being revised. A new technical criteria report will be available in May 2002. SFWMD staff intend to complete rule development and obtain final Governing Board approval for Loxahatchee River MFLs in late 2002.

The final MFL rule, in conjunction with a clear statement of restoration goals and objectives, will ultimately become a basis for the future management of water for the Northwest Fork of the Loxahatchee River. Compliance may require that operational schedules and protocols, and perhaps additional facilities, must be developed or improved within the northern Palm Beach County water management system, especially the Loxahatchee Slough and Grassy Waters Preserve. Additional improvements to water management systems in southern Martin County may also be required to provide this water.

It is important to note that the process of developing the numeric MFL criteria for the Northwest Fork of the Loxahatchee River has proceeded on a path parallel to development of this Comprehensive Water Management Plan. Certain assumptions were made in this plan regarding baseflows and hydroperiod performance targets for the Loxahatchee River and Loxahatchee Slough. In the MFL development process, the SFWMD is undertaking a more comprehensive examination of the impacts of river flow on salinity and water resources in the river, including effects on floodplain cypress, macroinvertebrate, fish, seagrass, oyster, and other communities. The final MFL significant harm standard will be somewhat different from the preliminary targets used in

this plan with respect to baseflows, and will also include duration or return frequency criteria as recommended by the scientific peer review panel.

Modeling results indicated that with full implementation of the recommended program of improvements, a baseflow of 65 cfs to the Northwest Fork of the Loxahatchee River could be achieved, except during significant drought conditions (**Table 2**). This may or may not be within the allowable ranges of frequency and severity constraints that will be defined by the forthcoming MFL criteria.

Table 2. Ability of Proposed Improvements To Meet Interim Flow Target of 65 cfs at the Lainhart Dam, Northwest Fork of the Loxahatchee River.

| Scenario | Anticipated Completion Date | Percent of Time Target (65 cfs) Flow Was Met over the Nine-Year Simulation Period |
|-------------------------------------|-----------------------------|---|
| Existing Conditions (1995 Base) | Current | 41 |
| With G-160 Project Only | 2004 | 62 |
| With G-160 and G-161 in Place | 2006 | 71 |
| With 2020 LECRWSP Projects in Place | 2011-2018 | 99 |

Section 373.042(1) also requires that if the proposed MFL criteria are not currently being met, a MFL "Recovery and Prevention Strategy" must be developed. This strategy identifies the process and time frames by which the adopted MFL will be achieved. The strategy may involve development of improved operations, additional structural features for water storage or delivery, and/or regulations that protect water resource functions.

PERFORMANCE

The modeling results presented in the Technical Support Document (Volume II) indicate that the identified program of improvements met the defined targets for agricultural and utility water supply and achieved hydroperiod restoration of the Loxahatchee Slough. As shown in **Table 2**, under current conditions, flows of 65 cfs or more occur less than half (41 percent) of the time. With the G-160 and G-161 improvements in place, these flows could be achieved 71 percent of the time.

With all of the identified improvements in place, the target flow of 65 cfs to the Northwest Fork of the Loxahatchee River could be met more than 99 percent of the time. During the very few periods when discharges over Lainhart Dam fell below 65 cfs (e.g., during the 1989-90 drought), flows were simulated as 50 cfs for approximately one week and 35 cfs for two weeks. The flow over Lainhart Dam was maintained at 35 cfs or higher throughout the entire simulated drought period.

The results in **Table 2**, based on modeling, indicate that until the projects proposed in the Lower East Coast Regional Water Supply Plan (LECRWSP) are constructed, extended periods may occur when the flows over Lainhart Dam are below the baseflow target of 65 cfs. The impacts of not meeting the baseflow targets for Northwest Fork of the Loxahatchee River are discussed below. This information provides a basis for possible actions that can be taken in the interim period before a program of improvements is fully operational.

ASSOCIATED BENEFITS

The entire program of identified improvements will require many years to complete. Construction of water projects of this scope and magnitude often requires more than a decade. Implementation of the identified improvements involves some Comprehensive Everglades Restoration Plan (CERP) components, including the siting of a single or multiple reservoirs that provide a combined storage volume of 48,000 acre-feet, acquisition of required lands, and construction. Local stakeholders have identified projects that could be implemented to achieve benefits sooner. In order to implement these interim projects, the local stakeholders must identify funding sources, develop agreements and schedules, and determine project management responsibilities. The purpose of the following discussion is to explain why specific projects should be expedited in order to reduce detrimental effects that will continue to occur if action is delayed.

The technical analyses revealed that certain adverse effects are intermittently ongoing and others are expected to arise due to future demands. These impacts include water shortages and environmental impacts. More detailed examination of one structural component is used to illustrate the factors involved. The C-18 Basin's performance is compared under existing "without project" conditions to an interim future condition when flowway improvements are provided that increase the gravity flow capacity from the Grassy Waters Preserve to the Loxahatchee Slough.

Performance without Improved Conveyance from Grassy Waters Preserve to Loxahatchee Slough

During predevelopment times, water from the vicinity of the Grassy Waters Preserve could flow north to the Loxahatchee Slough. However, the flow barrier created by construction of Northlake Boulevard and increased water demands by the City of West Palm Beach have reduced flow from the preserve to the Loxahatchee Slough. The current flow is negligible when the preserve is at or below a stage of 18.5 feet relative to the National Geodetic Vertical Datum (NGVD).

In the interim period, until a gravity flow connection is built, the 65 cfs target flow to the Loxahatchee River can be met only 41 percent of the time (**Table 2**). The Loxahatchee Slough provides a supplemental water supply sufficient to maintain a flow of approximately 30 cfs over Lainhart Dam if the stage in the slough is above its target hydroperiod. During dry periods, the other tributaries and ground water inflows will provide approximately 10 cfs of additional flow for a total of approximately 40 cfs

downstream of the confluence of Kitching Creek and the Northwest Fork of the Loxahatchee River. Providing 40 cfs instead of the target 65 cfs will result in movement of saltwater approximately 0.5 mile upstream of the confluence at Kitching Creek.

Performance with Improved Conveyance from Grassy Waters Preserve to Loxahatchee Slough

Hydraulic analyses indicate that up to 44 cfs can flow by gravity between the Grassy Waters Preserve and the Loxahatchee Slough with conveyance improvements both upstream and downstream of the existing 72-inch diameter culverts under Northlake Boulevard. In order to meet the full 150 cfs design criteria, additional more substantial improvements would be needed. For the existing culverts to be effective, the perimeter canal south of Northlake Boulevard must be improved and new culverts placed under the entrance road to the Nature Center (located on the south side of Northlake Boulevard). Once completed, these changes will provide significant benefits to the Loxahatchee Slough and the Northwest Fork of the Loxahatchee River.

Modeling studies indicate that in normal rainfall years the Loxahatchee Slough has limited water above its target hydroperiod available for release to supplement the baseflows to the Northwest Fork of the Loxahatchee River. During a typical three-month dry period, when local runoff to the Northwest Fork of the Loxahatchee River is insufficient to provide the target baseflow of 65 cfs, the actual daily flow results in a cumulative deficit of approximately 5,000 acre-feet. If the Loxahatchee Slough were full (17.5 feet NGVD) at the start of the dry season, only about 2,500 acre-feet of water would be available for discharge to the Northwest Fork of the Loxahatchee River to maintain baseflow. This number is approximately half of the normal demand, which strongly suggests that the Loxahatchee Slough cannot be the sole source of baseflow for the Northwest Fork of the Loxahatchee River. Under these conditions, extended periods frequently occur when baseflow targets cannot be met.

The addition, in the near term, of 44 cfs flow from the Grassy Waters Preserve would reduce the dry season deficit to approximately 1,000 acre-feet and essentially shorten the duration of hydroperiod deficit by one month. If the slough stage is at 17 feet NGVD at the end of the wet season, the benefit of receiving approximately 1,000 acre-feet of supplemental water from the preserve would be that the Loxahatchee Slough would reach a stage at the end of the dry season of 15.5 feet NGVD, approximately one month later than was predicted for "without" project conditions.

In conclusion, a phased approach to implementing the recommended improvements should be considered to meet baseflow targets in the Northwest Fork of the Loxahatchee River. This approach involves initially reconnecting the Grassy Waters Preserve to the Loxahatchee Slough by gravity driven conveyances while more elaborate facilities are being constructed to provide the improved flow capacity and storage that are needed to better protect the Northwest Fork.

Chapter 5

PROJECT IMPLEMENTATION

PROPOSED COMPREHENSIVE EVERGLADES RESTORATION PLAN (CERP) COMPONENTS AND PROJECT ELEMENTS IN NORTHERN PALM BEACH COUNTY

The overall plan for Everglades restoration was developed by the United States Army Corps of Engineers (USACE) and the South Florida Water Management District (SFWMD) and approved by congress in 2000. The proposed Comprehensive Everglades Restoration Plan (CERP) components and other project elements in northern Palm Beach County are described in this section, along with their estimated costs and schedules. These projects will be implemented using a combination of federal, state, regional and local funding and support. The individual components and elements were developed based, in part, on input from earlier drafts of the Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP) and resemble the list of recommended projects developed by local stakeholders in this planning process. The CERP adopted the early concepts of the NPBCCWMP and subsequent modeling in the Lower East Coast Regional Water Supply Plan (LECRWSP) confirmed their validity.

The CERP includes activities that were not considered by the local stakeholders, for numerous reasons including, but not limited to, the larger regional scope and 50-year design horizon of the CERP. The inclusion by the CERP of a larger set of water management goals and options, enhances the probability that the components identified by the CERP in the selected alternative will address subregional needs of northern Palm Beach County, concurrent with other regional requirements.

As noted in the discussion of historical hydrology, the current basins in the region were previously connected at high water stages. Opportunities exist in the CERP planning process to expand the boundaries of the study area to include additional contributing watersheds. The challenge is to create operational flexibility, which allows water to be moved as needed to maximize benefits over the widest range of hydrologic conditions, and to consider environmental, agricultural and urban needs concurrently. An example of such an opportunity is the role that the J.W. Corbett Wildlife Management Area may play in the NPBCCWMP. Excess water above the management area's desired hydroperiod range can be used as a water supply source. Early thinking was that this water could be directed to Lake Okeechobee and used for Everglades restoration; however, recent analyses have indicated that it may be better to use excess water from the Corbett Area in other locations, including northern Palm Beach County.

Several CERP components were combined to create the "North Palm Beach County Project," which has two parts, as discussed below. The components were consolidated to ensure that the interdependencies were evaluated concurrently and thus

minimize conflicts among competing goals. Recent estimated costs and timeframes for components and elements of the North Palm Beach County Project are shown in **Table 3**, but these are subject to change. A project management plan (PMP) for Part 1 of the North Palm Beach County Project will be completed in early 2002 and will identify the responsibilities of the local sponsors and govern the nature of future planning activities. Following the initial planning phase, a project implementation report (PIR) will identify recommended courses of action and the roles of local sponsors in its implementation. The PIR for the North Palm Beach County Project will be complete by March 2004.

Table 3. Northern Palm Beach County Comprehensive Everglades Restoration Plan (CERP)
Components - Parts 1 and 2.*

| Title | Projected Cost | Start Date | Finish Date |
|--|----------------------|------------|-------------|
| PART 1 - North Palm Beach County Project (X,Y,GGG, Pal-Mar, LWL, KPh1)** | | | |
| PMP Development X,Y,K Phase 1, GGG, Pal-Mar, Lake Worth Lagoon | \$300,000 | 04/02/2001 | 10/31/2001 |
| PIR X,Y,K Phase 1,GGG, Pal-Mar, Lake Worth Lagoon | \$14,343,000 | 11/01/2001 | 03/26/2004 |
| Pal-Mar and J.W. Corbett Wildlife Management Area Hydropattern Restoration (OPE) | \$10,447,000 | 03/29/2004 | 03/20/2009 |
| L-8 Basin Modifications (K Phase 1) | \$17,938,000 | 03/29/2004 | 03/18/2011 |
| C-51 & Southern L-8 Reservoir (GGG) | \$328,056,000 | 03/29/2004 | 03/14/2014 |
| Lake Worth Lagoon Restoration (OPE) | \$2,268,000 | 03/29/2004 | 03/21/2008 |
| C-17 Backpumping & Treatment (X) | \$19,835,000 | 03/29/2004 | 03/19/2010 |
| C-51 Backpumping & Treatment (Y) | \$31,892,000 | 03/29/2004 | 03/19/2010 |
| TOTAL | \$425,079,000 | | |
| PART 2 - North Palm Beach County Project (K Ph2, LL)** | | | |
| PMP Development K Phase 2, LL | \$300,000 | 05/01/2009 | 10/29/2009 |
| PIR K Phase 2,LL | \$7,042,000 | 10/30/2009 | 04/26/2012 |
| C-51 Regional Groundwater Aquifer Storage & Recovery (LL) | \$127,291,000 | 04/27/2012 | 10/15/2020 |
| L-8 Basin Aquifer Storage & Recovery (K Phase 2) | \$53,428,000 | 04/27/2012 | 10/18/2018 |
| TOTAL | \$188,061,000 | | |

* These are estimated costs and dates and are subject to change; X, Y, GGG, K, LL etc. are CERP component codes (see text).

The North Palm Beach County Project, Part 1 includes six separable elements -- Four have corresponding letter codes and two "other project elements" (OPEs), including: (1) Pal-Mar and J.W. Corbett Wildlife Management Area Hydropattern Restoration (OPE), (2) L-8 Basin Modifications (K - Part 1), (3) C-51 and L-8 Reservoir (GGG), (4) Lake Worth Lagoon Restoration (OPE), (5) C-17 Backpumping and Treatment (X), and (6) C-51 Backpumping and Treatment (Y). These separable elements were combined into a single project to address the interdependencies and trade-offs among the different elements and provide a more effective design of the overall project. Approximate locations of these projects are shown in **Figure 3**.

In conjunction with development of the PIR, authorization was given to move forward with the L-8 Reservoir Testing Project, using local and state funds for preliminary studies to determine if the proposed reservoir concept can hold water. Subsequently, when the L-8 Basin component is initiated, these funds will be credited as a matching contribution to the CERP project. The total (local and federal) cost of the testing project is not to exceed \$3,100,000.

The North Palm Beach County Project, Part 2 includes two separable elements. The C-51 Regional Groundwater Aquifer Storage and Recovery (ASR) system (LL) will provide an estimated additional long-term storage capacity of 170 million gallons per day (mgd) and the L-8 Basin ASR system (K - Part 2) will provide an estimated 50 mgd of storage capacity. These projects were separated and deferred into Part 2 (**Table 3**), to be consistent with time frames of the ASR pilot projects.

It is important to note that the PMP and PIR schedules for Part 1 of the North Palm Beach County Project reflect the local need to accelerate the federal process. In particular, the PIR schedule will enable land acquisition to begin as early as March 2004.

North Palm Beach County Project Implementation Report (PIR) - Part 1

Pal-Mar and J.W. Corbett Wildlife Management Area Hydropattern Restoration (OPE)

This separable element will consider improvements such as new or modified water control structures, canal modifications and the acquisition of 3,000 acres located between Pal-Mar and the J.W. Corbett Wildlife Management Area in Palm Beach County. The purpose of this element is to provide hydrologic connections between the J. W. Corbett Wildlife Management Area and: (1) the Moss Property, (2) the C-18 Canal, (3) the Indian Trail Improvement District (ITID), and (4) the L-8 Borrow Canal, in addition to extending the spatial extent of protected natural areas. These connections would reduce detrimental effects on native vegetation that occurred due to over inundation frequently experienced during the wet season. This element will also extend the footprint of the contiguous greenbelt to 126,000 acres, extending from the Dupuis Reserve near Lake Okeechobee across the J.W. Corbett Wildlife Management Area and south to Jonathan Dickinson State

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Park. This project element is scheduled to begin in September 2003 and be completed by March 2009.

L-8 Basin Modifications (K - Phase 1)

This separable element involves modifications to the L-8 Basin including a series of pumps, water control structures, and canal capacity improvements in the M-Canal. The purpose of this project is to construct the required conveyance to make the C-51 and L-8 Reservoir functional and thereby increase water supply availability while maintaining or enhancing flood protection for northern Palm Beach County areas. This component will also provide conveyances necessary to deliver flows required to enhance hydroperiods in the Loxahatchee Slough, increase baseflows to the Northwest Fork of the Loxahatchee River, and reduce high discharges to the Lake Worth Lagoon.

C-51 and Southern L-8 Reservoir (GGG)

This separable element includes a reservoir with a combined above-ground and in-ground storage capacity of approximately 48,000 acre-feet that is located immediately west of the L-8 Borrow Canal and north of the C-51 Canal in Palm Beach County. The initial design assumed a 1,800-acre reservoir with 1,200 usable acres with the water level fluctuating from 10 feet above grade to 30 feet below grade. The final size, depth, and configuration of this facility will be determined through more detailed planning and design.

The purpose of this element is to increase water supply availability, and attenuate discharge to the Lake Worth Lagoon and provide compatible drainage benefits for northern Palm Beach County areas. It will also provide flows to enhance hydroperiods in the Loxahatchee Slough, increase baseflows to the Northwest Fork of the Loxahatchee River, and reduce high discharges to the Lake Worth Lagoon.

Water will be pumped into the reservoir from the C-51 Canal and Southern L-8 Borrow Canal during the wet season, or periods when excess water is available, and returned to the C-51 and L-8 during dry periods. Additional projects will also direct excess water into the City of West Palm Beach Grassy Waters Preserve. This component or portions of this component may be implemented under a previous authorization. This component is scheduled to begin in March 2004 and be completed by September 2024.

Lake Worth Lagoon Restoration (OPE)

This element includes sediment removal in the C-51 Canal and sediment removal or capping within a distance of 2.5 miles downstream of the confluence of the C-51 Canal and Lake Worth Lagoon. A prototype project will be conducted to determine the feasibility and potential cost of removing and disposing of sediments in the lagoon versus capping them. This project includes the evaluation of sediment traps to reduce future accumulation of sediment.

The purpose of this element is to improve water quality and allow for the reestablishment of sea grasses and benthic communities. The elimination of the organically enriched sediment from the C-51 Canal discharge will provide for long-term improvements to the lagoon and enable success for additional habitat restoration and enhancement projects planned by Palm Beach County. This component is scheduled to begin in March 2004 and be completed by March 2008.

C-17 Backpumping and Treatment (X)

This element includes backpumping facilities and a STA with a total storage capacity of approximately 2,200 acre-feet located in northeastern Palm Beach County. The design assumes a 550-acre STA with the water level fluctuating up to 4 feet above grade. The final size, depth and configuration of this facility will be determined through more detailed planning and design, and will address appropriate pollution load reduction targets necessary to protect receiving waters (e.g., the City of West Palm Beach Grassy Waters Preserve).

The purpose of this element is to increase water supplies to the Grassy Waters Preserve and Loxahatchee Slough by capturing and storing excess flows currently discharged to the Lake Worth Lagoon from the C-17 Canal. Excess C-17 Canal water will be backpumped through existing canals and proposed water control structures to the STA which will provide water quality treatment prior to discharge into the Grassy Waters Preserve. This component is scheduled to begin in September 2003 and be completed by March 2010.

C-51 Backpumping and Treatment (Y)

This element includes backpumping facilities and a stormwater treatment area (STA) with a total storage capacity of approximately 2,400 acre-feet located in Palm Beach County. The design includes a 600-acre STA with the water level fluctuating up to 4 feet above grade. The final size, depth and configuration of this facility will be determined through more detailed planning and design, and will address appropriate pollution load reduction targets necessary to protect receiving waters (e.g., the West Palm Beach Grassy Waters Preserve). The purpose of this project is to increase water supplies to the Grassy Waters Preserve and Loxahatchee Slough by capturing and storing excess flows currently discharged to the Lake Worth Lagoon from the C-51 Canal. The conceptual design allows excess C-51 Canal water to be backpumped through existing and proposed water control structures and canals to the STA. The STA will provide water quality treatment prior to discharge into the Grassy Waters Preserve.

North Palm Beach County Project Implementation Report (PIR) - Part 2

C-51 Regional Groundwater Aquifer Storage and Recovery (LL)

This element includes a series of ASR wells with a total capacity of 170 mgd, associated pre- and post- water quality treatment to be constructed along the C-51 Canal, and canals that can receive water from the C-51 Canal. The conceptual design assumes 34 well clusters, each with an individual capacity of 5 mgd, fed by a combination of vertical and horizontal wells located near existing canals. The conceptual design includes disinfection pretreatment and post storage aeration. The level and extent of treatment and number of the ASR wells may be modified based on findings from a proposed ASR pilot project.

The purpose of this element is to capture and store excess flows from the C-51 Canal, currently discharged to the Lake Worth Lagoon, for later use during dry periods. The ASR facilities will be used to inject and store surficial aquifer ground water adjacent to the C-51 Canal into the upper Floridan aquifer instead of discharging the canal water to tide. Water will be returned to the C-51 Canal to help maintain canal stages during the dry-season. If water is not available in the ASR system, existing rules for water delivery to this region will be applied. This component is scheduled to begin in March 2011 and be completed by March 2020.

L-8 Basin Aquifer Storage and Recovery (ASR) (K - Phase 2)

The L-8 Basin ASR element will increase water availability and improve drainage for northern Palm Beach County by adding long-term storage in a 50 mgd well system. This component will provide water storage capacity that can be used to enhance hydroperiods in the Loxahatchee Slough, increase baseflows to the Northwest Fork of the Loxahatchee River, meet urban water demands and reduce annual discharges to the Lake Worth Lagoon.

During periods when the Grassy Waters Preserve is above desired stages, up to 50 mgd will be stored in the Floridan aquifer using ASR wells. The initial design of the ASR wells assumed that ten wells would be constructed and that each well would have a capacity of 5 mgd. The source of water for the ASR system is ground water supplied from a combination of vertical and horizontal wells in the Surficial Aquifer System (SAS). The ASR systems include disinfection pretreatment and postwithdrawal aeration. The level and extent of treatment and number of the ASR wells may be modified based on findings from a proposed ASR pilot project and based on local conditions encountered during development of the PIR for Part 2. The operation of the L-8 Basin ASR system will be synergistic with the proposed reservoir and conveyance improvements that are identified in the CERP North Palm Beach County Project. This component is scheduled to begin in March 2011 and be completed by December 2017.

Other Federal Projects in Northern Palm Beach County

Other federal (non-CERP) projects within the planning area that have federal funding or support are discussed, including L-8 General Re-evaluation Report (GRR) Phases 1-4, the S-155A Structure, and Regional Reuse of Reclaimed Water.

LOCAL OPTION PROJECTS

The eight projects listed below were identified by the northern Palm Beach County TAC and PAC as activities that could potentially enhance the ability to effectively manage regional water resources. General locations of these projects are shown in **Figure 4**.

The following section provides brief descriptions of the features of eight local option projects. A table at the end of the section summarizes overall costs and key participants for seven of these projects, to the extent that these are presently determined. The status of the eighth project, the C-18 Reservoir, is uncertain (see discussion below) and hence was not included in the table. The potential usefulness of these projects was assessed through the use of hydrologic simulation models. In some cases these projects provide improvements that address existing problems. In other cases they enhance the ability to realize local benefits from regional projects that are being constructed through the CERP. In many ways, these projects form the core of the NPBCCWMP that will require considerable local support and commitment to be completed.

L-8 Pilot Water Storage Project

The Pilot Water Storage Project is a separate but related project to the L-8 General Re-evaluation Report project that is discussed in the “Related Projects” section of this document. This project is currently underway and addresses geophysical and environmental questions about the use of abandoned rock mining pits, located near the junction of the L-8 and C-51 canals, as a reservoir. An area of 1,200 acres may be available. With an estimated operating depth of 40 feet, this reservoir has a potential capacity of 48,000 acre-feet.

Using a 100-acre pit excavated to approximately 35 feet below land surface, the pilot project will help to determine whether a subterranean seepage barrier will be needed around the perimeter of the reservoir to prevent the inflow of connate groundwater with elevated chloride levels from seeping into the reservoir. Local partners in the study include Indian Trail Improvement District (ITID), Palm Beach County, and the City of West Palm Beach. The data from the pilot project will be used in both the L-8 GRR and Northern Palm Beach County PIR. Work on the pilot project is being performed by a consultant. With guidance from the local partners. The scope of work for the pilot project is contained in a consent agreement between the SFWMD and ITID.

The Pilot Water Storage Project is being funded at a cost of \$440,000. The SFWMD will pay approximately 75 percent of the cost. This project is expected to conclude early in 2002. In addition, the local partners have received initial funding for the

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L-8 Reservoir Testing Project (see below) to determine operational parameters for the reservoir.

If this pilot project concludes that the rock mining pits will not require seepage barriers, and no significant impacts are likely to occur from ground water chloride levels, the next step will be to proceed with the L-8 Reservoir Testing Project.

L-8 Reservoir Testing

In conjunction with development of the PIR for Phase I CERP components, authorization was given to move forward with the L-8 Reservoir Testing Project, using local and state funds. This project is designed as a follow-up to the L-8 Pilot Water Storage Project to determine how a reservoir at this location would actually perform during operation. This three-year study will use two existing rockpits and evaluate the ability to move water into and out of these facilities to meet water supply and flood control requirements. The quality of water in the pits and adjacent areas will also be monitored to determine the ability to meet Class I and Class III water quality standards. Subsequently, when the L-8 Basin component is initiated, these funds will be credited as a matching contribution to the CERP project. The total (local and federal) cost of the reservoir testing project is not to exceed \$3,100,000.

M-Canal Widening

The City of West Palm Beach has begun a project to expand the conveyance capacity of the M-Canal to 450 cfs. The current estimate of total project cost is approximately \$3,000,000 and the project is scheduled for completion in 2005. The City of West Palm Beach budgeted \$562,000 in 2000 to begin this multiyear project and also received a grant from the United States Environmental Protection Agency/Veteran's Administration - Department of Housing and Urban Development (USEPA/VA - HUD) in the amount of \$1,412,000. The SFWMD provided cooperative funding via state appropriations of \$750,000 during Fiscal Year (FY) 2000. Under the terms of an interlocal agreement that was approved in October 2001, ITID will provide \$200,000 to reimburse the City of West Palm Beach for a portion of the \$500,000 initial local cost. The City of West Palm Beach anticipates that the sale of fill material will reduce the overall construction costs. As mitigation for the environmental impacts associated with this project, the City of West Palm Beach is required to make conveyance improvements within and adjacent to the Grassy Waters Preserve that will provide additional flow capacity into the Loxahatchee Slough. For purposes of the Phase 2 modeling in the L-8 GRR, an assumption is made that the M-Canal widening will be completed on schedule and will not be subject to evaluation as an alternative in that process.

Control 2 Pump Station

A verbal agreement exists between the City of West Palm Beach, ITID, and SFWMD to build a new pump station of 400 cubic feet per second (cfs) capacity at the western end of the M-Canal. This new pump station will allow more water to be

pumped from L-8 Canal into the M-Canal for delivery into the Grassy Waters Preserve. The proposed location of the pump station is the subject of a cooperative agreement among the participants that will be developed in FY 2002. Water quality related to the relocation of this pump is not an issue.

The most recent cost estimate for this project is between \$3,500,000 and \$4,000,000. The SFWMD has made a congressional grant application for \$2,000,000 during FY 2002. If successful, the balance would be the responsibility of the local partners. An immediate priority is to develop a written agreement between the local partners. The first phase, in FY 2002, would consist of a siting study, preliminary design, and permitting at an estimated local cost of \$250,000. Construction is anticipated to occur in two phases, corresponding roughly with FY 2003 and FY 2004. The local portion of construction cost is estimated as \$1,750,000.

City of West Palm Beach Aquifer Storage and Recovery (ASR) Project

The modeling for the NPBCCWMP assumed that ten 5-mgd wells with a total of 5,000 acre-feet of storage capacity were constructed at some location near or within Grassy Waters Preserve. The wells would inject or withdraw water depending on the stage in the preserve. Under the evaluated scenario, injection would occur at a stage of 18.0 feet NGVD in the wet season and 18.2 feet NGVD in the dry season. Withdrawal would occur when water levels in the preserve reached a stage of 17.9 feet NGVD for both the wet and dry season.

In FY 2001, the City of West Palm Beach and SFWMD shared the cost of the siting study, using local funds and proceeds from an Alternative Water Supply Grant to determine desirable locations for the 50 mgd capacity ASR facilities in the vicinity of the Grassy Waters Preserve, M-Canal, and C-18 Basin. Once the siting study is complete, a pilot study to construct one 5-mgd test well will begin, which is estimated to cost \$2,200,000. The anticipated cost of the completed wellfield is approximately \$12,000,000 to \$15,000,000. Where applicable, funding agreements between the City of West Palm Beach and the SFWMD will be finalized at the conclusion of the siting study.

City of West Palm Beach's Wetlands-Based Water Reclamation Project

The City of West Palm Beach's Phase 1 Wetlands-Based Water Reclamation Project calls for the development of a 10 mgd reuse system. The modeling assumed that advanced-treated reclaimed water could be discharged to nearby wetlands to provide recharge, pumped from groundwater, and indirectly routed into the Grassy Waters Preserve until water levels in the preserve reached a dry season threshold of 18.2 feet NGVD. The City is currently constructing this Wetlands-Based Water Reclamation Project and anticipates completion in the summer of 2003.

Since the analyses for this plan were completed, additional demands for reclaimed water have been identified and are being addressed as part of an ongoing Northern Palm Beach County Reuse Project Master Plan Study. This effort is listed in this plan because it is currently underway and has obvious benefits to the region, even though these benefits were not incorporated into the modeling process. The Northern Palm Beach County Reuse Project Master Plan Study is discussed in the "Related Projects" section. The full project will transport reclaimed water (10-15 mgd) from the East Central Regional Wastewater Treatment Facility (Palm Beach County Utilities, Lake Worth, Palm Beach, Riviera Beach, West Palm Beach) northward to meet the growing needs of communities in northern Palm Beach and southern Martin counties, including Jupiter and Jupiter Island and possibly Palm Beach Gardens and Tequesta. The study will be completed in 2002. Funding for the full project will involve cost-sharing among the utilities, local governments, and the SFWMD.

Flowway Improvements from Grassy Waters Preserve to Loxahatchee Slough (G-161 Structure)

The benefits to the Loxahatchee Slough and the Northwest Fork of the Loxahatchee River from creating an interim conveyance of up to 44 cfs are discussed previously (see "Solution Development" section) and in the Technical Support Document. However, an additional flow above this quantity for the protection of the slough and the river is desirable. The need for a total conveyance capacity of 150 cfs from the regional system (e.g., L-8 Canal) through the Grassy Waters Preserve to the C-18 Basin was determined based on modeling results. A desirable conveyance route for this water was identified to be from the L-8 Canal through the M-Canal to the Loxahatchee Slough portion of the C-18 Basin.

To provide conveyance rates above 44 cfs through this route, improvements to the perimeter canal of the Grassy Waters Preserve, installation of operable gates, stabilizing of existing conveyance channels under the railroad trestle, construction of box culverts under Northlake Boulevard, and creation of a flowway from Northlake Boulevard to C-18 Canal would be required. The Palm Beach County Department of Environmental Resources Management (DERM) has indicated that it would prefer a design that includes a bridge at the junction with Northlake Boulevard, which would facilitate the movement of wildlife and canoeists between the two water bodies. Palm Beach County is taking the lead to design facilities, with in-kind contributions from the SFWMD. Agreement exists to go forward with an interim plan to take advantage of the 44 cfs of gravity flow:

- By June 2003, the City of West Palm Beach will make maintenance improvements in the canal that parallels Northlake Boulevard on the south side and install three 72-inch diameter culverts with a 50 cfs capacity underneath the entrance to the nature center on the south side of Northlake Boulevard. An engineering evaluation of the necessity of the City's C-5 Structure will be completed to determine its function in the overall design. In this same period, the SFWMD will conduct surveys to determine the preliminary design of the flowway

improvements for G-161 between the Grassy Waters Preserve and the Loxahatchee Slough. The overall design phase will be concluded.

- By 2007, the C-2 Pump Station will be constructed, allowing the Grassy Waters Preserve to receive a total of 400 cfs from the regional system for distribution to the Northern Palm Beach County Planning Area. This includes up to 150 cfs to help meet hydroperiod targets in the Loxahatchee Slough and MFL deliveries to the Loxahatchee River. If included in the final design, the box culverts under Northlake Boulevard (the G-161 Structure) will be constructed.

The current estimate for this aspect of the project is \$1,200,000, if it is included in the final design. Cost estimates are currently under development for other project features. The participating agencies will develop Memorandums of Understanding (MOUs) concerning maintenance and operation responsibilities and operational protocols for the new facilities.

Loxahatchee Slough (G-160) Structure

As modeled, the proposed G-160 Structure will have two remotely operated gates. Accurate discharges in the 0-100 cfs range will be possible, as well as larger discharges. The design discharge capacity for a 1-in-100 year storm event will be 1,100 cfs. This structure will serve to impound water at stages and durations necessary to achieve hydroperiod restoration targets in the Loxahatchee Slough. The slough will also serve as a source of water to provide baseflows to the Northwest Fork of the Loxahatchee River when the stage in the slough is above the hydroperiod target.

Operation will be guided by modeling results that indicate that a viable rainfall driven hydroperiod can be achieved in the slough during a normal rainfall year. Recent field measurements in the Loxahatchee Slough, west of the C-18 Canal, indicate that local rainfall in a normal year is sufficient to fill the slough to 17.0 feet NGVD. This stage declines slowly to a minimum of 15.4 feet NGVD, primarily by evaporation and secondarily by seepage losses. The resulting end of dry season stage is just slightly below the target hydrograph stage of 15.5 feet NGVD. The slough is completely dry (except for the C-18 Canal) when the water level is below 15.0 feet NGVD.

With the current drainage area and control constraints, little or no water can be released through the proposed structure in years with average rainfall without reducing the slough's hydroperiod. However, the redirection of water from the adjacent (west) Sandhill Tract will provide additional water. The South Indian River Water Control District (SIRWCD), including Jupiter Farms, is a primary source of water to the Northwest Fork of the Loxahatchee River. If discharge from SIRWCD is insufficient, water is imported from the C-18 Basin through the G-92 Structure. When water levels in the slough are above the target hydroperiod water can be released to supplement the baseflow requirement to the Northwest Fork of the Loxahatchee River. Modeling indicates that if the slough were full

at the start of the dry season, (e.g., 17.5 feet NGVD), approximately 2,500 acre-feet would be available for release to the river. Since this quantity alone is insufficient to meet downstream demands, a number of supplemental sources are planned. If C-18 Basin water is insufficient to meet the needs of the Northwest Fork of the Loxahatchee River then water may be imported from the Grassy Waters Preserve when hydraulic capacity is available.

Based on a recent agreement, a large development project (Taylor Woodrow Communities at Mirasol, Ltd.) near the slough will provide \$1,000,000 towards cost of G-160. The basis for the agreement is a SFWMD Environmental Resources Permit requirement to mitigate on-site wetland impacts resulting from the development. Palm Beach County is a party to the funding agreement. Permitting, construction, and operation of G-160 will be managed by the SFWMD. State and federal permit applications were submitted in early March 2001 and the goal is to complete construction on or before December 1, 2006.

C-18 Reservoir

The option of creating a distributed storage system was considered in the planning analysis. The majority of the demands and the resulting need for storage are associated with the L-8 Basin and with flow to the Grassy Waters Preserve (which includes water passed through to the City of West Palm Beach's water treatment plant). Two reservoir sizes were modeled. The first reservoir size was small and reflected the fact that at the time of formulation of the plan (1997) there were no willing sellers of large (>200 acre) parcels within the C-18 Basin. The NPBCCWMP Policy Advisory Committee (PAC) and Technical Advisory Committee (TAC) decided to perform only limited assessments of reservoirs as result of the lack of willing sellers. This reservoir was modeled with a footprint of 300 acres. No specific site for the conceptual reservoir was identified, and the size was based on the assumption that no tract of land larger than 300 acres was available in the basin. A rate of 300 cfs was assumed for pumping into, and discharge out of, the reservoir. The effective storage depth was determined to be 6 feet for a total available storage volume of 1,800 acre-feet. This reservoir did provide some minor benefits by storing wet season water for use during the dry season, but was inadequate to provide water at the end of the dry season or during a drought. For example, if 50 cfs (100 acre-feet per day) of supplemental water were needed to maintain salt water downstream of Kitching Creek then, even when full, this reservoir would provide only 18 days of supply.

The second reservoir was sized to meet the normal dry season needs without concern for land acquisition. A storage volume of 6,000 acre-feet was identified. To prevent excessive evaporation losses, the reservoir was assumed to have a storage depth of at least 6 feet. This size reservoir was effective in storing wet season runoff for use during normal dry seasons but was insufficient to meet local needs during a drought with a 1-in-10 year return period. A considerable benefit of a reservoir within the C-18 Basin would be the ability to capture the high quality wet season discharges from the J.W. Corbett Wildlife Management Area for subsequent use.

A distributed storage system has an advantage in terms of operational flexibility; however, trade-offs are involved. For example, economies of scale can negatively affect land assemblage and construction costs. In the case of the C-18 Reservoir, the availability of large tracts of land is a limiting factor. Although potential benefits of this option were identified, due to the lack of specific size, siting, and costs, implementation of this option is not recommended at this time. A C-18 Reservoir may also be included in the final CERP reservoir configuration.

Summary of Local Option Project Costs, Schedules, and Partners.

Table 4 indicates the proposed implementation of the local option projects discussed above, including estimated total costs, local costs, start and end dates, and potential partners. Because the SFWMD will be assuming responsibility for half of the local costs of these projects, the SFWMD will ensure that water supply benefits to downstream users are protected through operating agreements on key water management structures.

IMPLEMENTATION THROUGH REGULATION AND PERMITTING

Conveyance to Improve Recharge within the Town of Jupiter

Ground water modeling conducted in association with the LECRWSP identified an area of potential saltwater intrusion at Jupiter's existing surficial wellfield. Impounding additional surface water and an increase in the head differential above this area can provide better protection for the wellfield. A process to explore such alternatives is recommended.

South Indian River Water Control District (SIRWCD)

The SIRWCD is a considerable source of water to the Northwest Fork of the Loxahatchee River. The modeling assumed that the lateral control levels described in the Joint Application by FDEP and the SFWMD titled *Loxahatchee River Restoration Plan* (dated February 1984) will be implemented through the installation of operable control structures. The operable control structures will maintain the desired minimum levels in the canals and will open when discharges are necessary. Specifically, SIRWCD Lateral Controls LCS-2 through LCS-6 start to discharge at 12.5 feet NGVD. LCS-2 is located slightly west of 105th Avenue along Canal Number 7. The discharge from SIRWCD to the C-14 Canal will be controlled by the discharge capacity of the Lainhart Dam and the storage available in the SIRWCD. If SIRWCD's discharge to the Northwest Fork of the Loxahatchee River is insufficient, water is imported from the C-18 Basin through the G-92 Structure.

Table 4. Northern Palm Beach County Comprehensive Water Management Plan Projected Funding by Project.

| Project | Year Initiated | Estimated Cost (\$ Millions) | | | | Year Comp | Partners (b) |
|---|----------------|------------------------------|-----------|---------|----------|-----------|-----------------------|
| | | Total | Local (a) | FY 02 | FY 03-05 | | |
| L-8 Pilot Water Storage | 2000 | \$.44 (c) | \$.44 | N/A (d) | N/A | 2002 | PBC, WPB, ITID, SFWMD |
| L-8 Reservoir Testing Project | 2002 | \$3.1 | \$2.1 | \$2.1 | TBD | | PBC, SFWMD, USACE |
| L-8 Pump Station (C-2) Diversion siting study | 2001 | 4 | 2 | \$0.5 | 3.5 | 2005 | WPB, ITID, SFWMD |
| M-Canal Widening | 2000 | \$3 | \$1.6 | \$0.7 | 1.4 | 2005 | WPB, SFWMD , ITID |
| ASR Wellfield Feasibility and Pilot | 2001 | \$2.27 (e) | \$1.17 | \$0.4 | \$1.8 | 2004 | WPB, SFWMD |
| WPB Wetland Reclamation Phases 1 & 2 | 2000 | \$21.4 | \$12.6 | \$8.8 | N/A | 2003 | WPB, SFWMD USEPA |
| G-161 and Flowway Improvements | 2001 | \$1.2 (h) | \$1.2 | -- | \$1.2 | 2004 | PBC, WPB, SFWMD |
| 3-72 inch Culverts | 2001 | 0.1 | 0.1 | 0.1 | N/A | 2003 | |
| G-160 Loxahatchee Slough Structure | 2000 | \$2.5 | N/A | (g) | (g) | 2006 | PBC, SFWMD, Private |
| Total | | \$38.01 | \$21.21 | \$14.20 | \$7.74 | | |

Notes: (a) Local costs are assumed to be the nonfederal funded portions of total costs, including combined SFWMD, local and other government contributions. Local costs are assumed to be 50 percent of total project costs for general planning purposes; (b) PBC = Palm Beach County, WPB = City of West Palm Beach, ITID = Indian Trails Improvement District, ECR = East Coast Regional Water Utility, Jupiter = Town of Jupiter Water Utility, ENCON = Loxahatchee River Environmental Control District, USEPA = United States Environmental Protection Agency, USACE = United States Army Corps of Engineers; (c) Pilot project to collect geophysical data separate from L-8 GRR Phase 1 (see Table 5); (d) Further testing and engineering design absorbed into "Reservoir Testing Project" under CERP; (e) Feasibility study and siting of one 5 mgd pilot well only; (f) CERP anticipates a (10)-5 mgd ASR wellfield; (g) Construction administration costs only (h) cost may be higher if a bridge is used.

Mirasol

The rerouting of the Old Marsh discharge is necessary to facilitate the storage of water above 17.0 feet NGVD in the portion of the Loxahatchee Slough east of the C-18 Canal. This and other improvements will be constructed as part of the Mirasol (formerly known as Golf Digest) project, located on PGA Boulevard west of the Florida Turnpike in Palm Beach Gardens, and are discussed in their operational plan (SFWMD, 2000). The following information provides a summary of the predevelopment and postdevelopment water management and water conservation/budget aspects of this project to facilitate a better understanding and description of its effects on water management, water supply, and environmental resources.

Predevelopment Conditions

The original Loxahatchee Slough and Loxahatchee River system has been altered by numerous facilities constructed by man. The primary slough component is the C-18 Canal that was built by the USACE during the late 1950's. This canal, which is presently maintained at 14.8 feet NGVD, drains the slough and directs water to the Southwest Fork of the Loxahatchee River via the S-46 Spillway Structure and to the Northwest Fork via the G-92 Control Structure.

The predevelopment Mirasol site contained numerous ditches with one primary ditch connected to the Florida Turnpike borrow canals and the Florida Turnpike Interchange at PGA Boulevard. This primary east-west ditch connects into the existing outfall canal from the Old Marsh and Eastpointe projects (located along the perimeter of the eastern portion of the Loxahatchee Slough), which continues down to an overflow point into the C-18 Canal. The primary canal is relatively deep (> 5 feet) allowing water to be conveyed when the C-18 Canal stage is below the ground surface (~15.5 feet NGVD). The point of connection contains a set of USACE project culverts with risers that have been left open such that the upstream canal and ditch system have water levels fluctuating at the same levels as those within the C-18 Canal. Historically, it has been documented that this open connection allows water from the C-18 Canal to backflow into the Mirasol site ditch system, thus providing recharge to the Seacoast Utility Authority Hood Road Wellfield, which is located just east of the property. This original backflow of recharge water was documented to be up to 1.0 mgd as part of the SFWMD Water Use Permit issued to Seacoast Utility Authority for the Hood Road Wellfield. Further analysis of the existing drainage system as part of the permitting of the Mirasol project indicated that the quantity of recharge water that backflowed from the C-18 Canal was as high as 6.8 mgd. This high rate is believed to be due to water backflowing into the eastern portion of the slough to refill wetland areas inadvertently drained when the S-46 Structure is opened.

Water Management Plan

The primary benefit associated with construction of the water management system for the Mirasol site is the ability to manage and control water entering and leaving the site where previously it was uncontrolled. Flows from the Old Marsh and Eastpointe projects can now be redirected into the Mirasol water management system for additional storage, water quality treatment, on-site wetland hydroperiod improvements, and ultimate discharge (overflow) into Loxahatchee Slough, as opposed to discharging directly to the C-18 Canal. Overflow from the Mirasol site will be directed to the eastern portion of Loxahatchee Slough via a spreader swale, to help maintain/restore hydroperiods in the slough.

Onsite water levels are now maintained at higher elevations than could be maintained previously. The eastern portion is controlled at 16.8 feet NGVD and the smaller western portion controlled at 15.0 feet NGVD. The water budget model prepared for the site indicates a 23 percent reduction in annual flows off-site, compared to predevelopment conditions. The project improves the ability to restore the eastern portion

of the slough because a berm has been constructed on the west and north sides of the Old Marsh outfall canal that prevents draining of the slough.

The water management system under construction will allow (by gravity) an annual average inflow from C-18 Canal of 1.3 mgd, rather than the 2.7 mgd average flow that occurred historically, to recharge the Hood Road Wellfield. Under the gravity recharge system, the 6.8 mgd maximum monthly inflow from the C-18 Canal is reduced to 3.3 mgd and is cut off entirely when canal stages drop below 14.0 feet NGVD (before construction of G-160). Seepage losses from the Eastpointe project are reduced by 69 percent and on-site aquifer recharge is increased by 83 percent. In addition, the two proposed golf courses will be irrigated using 1.3 mgd of reclaimed water from Seacoast Utility Authority. The water management system provides detention for the first 1.5 inches of stormwater runoff for water quality treatment purposes in accordance with Outstanding Florida Waters Rule requirements. An additional 1.5 foot of storage is provided in the west basin for dry season storage and transfer to the east basin in dry times.

The project provides one million dollars towards construction of the new C-18 Water Control Structure (G-160) that will restore wetland hydroperiods within the slough to nearly historic levels. Reflooding of the slough will be possible because of design features in the Mirasol project to protect adjacent property from flooding, by the following:

- Redirecting flows from the Old Marsh and Eastpointe projects
- Eliminating the gravity flow from the Old Marsh outfall canal
- Construction of berms to protect Mirasol properties

In addition, increased water retention on the property, more efficient management of lakes and wetlands, and the inflow of 1.3 mgd of reclaimed water that will be used for irrigation, means that this area is less reliant on flow from the C-18 Canal to provide onsite irrigation water and recharge to adjacent wellfields. Due to the improvements provided by the Mirasol project, Seacoast Utility Authority was issued a new permit that allows pumpage from Hood Road Wellfield to be increased from an annual average of 10.4 mgd up to 13.6 mgd, while decreasing the amount of flow needed from C-18 Canal from an annual average daily flow of 2.7 mgd down to 1.3 mgd.

Chapter 6 RELATED PROJECTS

RELATED WATER MANAGEMENT PROJECTS

Table 5 identifies additional projects, which are proposed or are already underway, and are being supported by the Lower East Coast Regional Water Supply Plan (LECRWSP), other South Florida Water Management District (SFWMD) planning efforts or local government plans. Regional Reuse of Reclaimed Water and Development of Minimum Flows and Levels (MFLs) are two examples of projects that were identified in LECRWSP recommendations. These projects, in general, were not considered in the planning or modeling efforts for the Northern Palm Beach Comprehensive Water Management Plan (NPBCCWMP) because they were in the early planning stages and/or their effects could not be quantified at the time.

Table 5. Related Projects in the Planning Area.

| Project | Year Initiated | Estimated Costs (\$ Millions) | | | | Year Finished | Partners (b) |
|---|------------------------------|-------------------------------|--------------|--------------------|----------|------------------------------|---|
| | | Total | Local (a) | FY 02 | FY 03-05 | | |
| Minimum Flow and Level Rule Development | 2000 | N/A | | | | 2002 | SFWMD |
| Northern Palm Beach County Reclaimed Water Master Plan Master Plan/Feasibility Design/Construction | 2001 2002 (h) | \$.14 \$16 | \$.14 \$8 | \$.14 \$1.5 (e) | \$8 | 2002 2009 | ECR, Jupiter, ENCON, Martin County, SMWU, WCI, Cogentrix |
| L-8 General Re-Evaluation Report Phase I (Plan Formulation) Phase II (Initial Screening) Phase III (Interim Screening) Phase IV (Final GRR) | 1999 2000 2003 2003 | .11 | .11 | (d) | | 2001 2002 2004 2004 | PBC, ITID, WPB, SFWMD USACE, SFWMD USACE, SFWMD USACE, SFWMD |
| S-155A Structure | 2001 | \$3.6 | | | | 2003 | USACE, SFWMD |
| C-17 Flood Study Phase 1 (Model Development) Phase 2 (Application) | 2002 2003 | \$.154 \$.060 | \$.154 | \$.154 | | 2002 | Northern PBC Improvement District, SFWMD |
| Cypress Creek/Pal-Mar/ Grove Basin Studies and Plan | 2002 | TBD | | | | 2003 | SFWMD |

Notes: (a) Local costs are assumed to be the nonfederal funded portions of total costs, including combined SFWMD, local and other government contributions. Local costs are assumed to be 50 percent of total project costs for general planning purposes; (b) PBC = Palm Beach County, ECR = East Coast Regional Water Utility, Jupiter = Town of Jupiter Water Utility, ENCON = Loxahatchee River Environmental Control District, SMWU = South Martin Water Utilities; WCI = Watermark Communities, Inc.; USACE = United States Army Corps of Engineers; (c) L-8 GRR Phase 1 identified the Palm Beach Aggregate site reservoir in the majority of 9 alternatives; (d) Further testing of alternatives involving the reservoir at the Palm Beach Aggregate site is absorbed into "Reservoir Testing Project" under the CERP project management plan; (e) Design and permitting phases only; (f) Pilot project will be 1-2 mgd; (g) 50-100 mgd ultimate facility capacity within indefinite time horizon (h) this phase will proceed only after feasibility is demonstrated.

Although the projects identified in this chapter may substantially affect future water supplies in northern Palm Beach County, they are not included in the cost of this plan because they are funded from other sources. These efforts will be reevaluated in the future and may be incorporated in future revisions of the LECRWSP, as appropriate.

Minimum Flows and Levels Rule Development

This project is underway by SFWMD to develop MFL criteria for the Northwest Fork of the Loxahatchee River and Estuary by 2002. Additional information concerning this activity is described in the “Solution Development” section.

Northern Palm Beach County Reclaimed Water Master Plan

The SFWMD, in cooperation with local utilities and private interests, is conducting a master plan study to determine the capability of conveying reclaimed water from central Palm Beach County to meet current and future demands for irrigation water in northern Palm Beach County and southern Martin County. The Upper East Coast and Lower East Coast Regional water supply plans have concluded that historically used sources of water in these areas are not sufficient to support the projected demands. Existing wastewater utilities in these areas have committed currently available supplies of reclaimed water and projected volumes will not be sufficient to meet the future needs. About 12 mgd of reclaimed water was reused in this area during 1998. Based on discussions with the Seacoast Utility Authority, preliminary estimates developed by the SFWMD indicate projected development based on land use maps in this area will need at least 20 mgd during dry periods and considerably more during drought periods. The study will be completed in the summer of 2002.

The total project cost is estimated at this time to be \$16 million with 50 percent of the cost provided by the federal government. Approximately \$140,000 has been committed to the initial feasibility phase that will result in a master plan. Project cooperators include the SFWMD, East Central Regional Wastewater Control Board, the Loxahatchee River Environmental Control District, the Town of Jupiter, Watermark Communities, Inc., Martin County, South Martin Regional Utilities, and Cogentrix. The SFWMD ultimately assumes responsibility for the primary role of local sponsorship and local cost-share. The SFWMD in cooperation with local partners, will design, permit, and construct the project if proven feasible.

L-8 Basin General Re-evaluation Report (GRR)

In 1968, Congress authorized modifications to the L-8 Project to address additional water needs within the L-8 Basin and surrounding areas, and provide more effective water delivery. The plan included construction of a pump station located near Lake Okeechobee, an operable gate structure capable of acting as a divide structure in the L-8 Borrow Canal and the addition of a new canal (C-300), connecting the existing L-8 Borrow Canal and the existing C-18 West. The projects authorized in 1968 were never constructed; however, the need for additional water and better means of delivery must be addressed, along with the ability to control flooding. Changes in policies and conditions have mandated that the previously completed study be reanalyzed.

The United States Army Corps of Engineers (USACE) has initiated a four-phase planning process that will culminate in a General Re-evaluation Report (GRR) in 2004.

This GRR will integrate a feasibility report level of documentation with an Environmental Impact Statement (EIS) to produce a single decision document. This GRR is being prepared pursuant to USACE regulations to seek modifications of the authorized improvements to the L-8 Basin. It will provide a reformulation and assessment for completing the authorized project in the L-8 Basin.

The GRR covers the L-8 Basin and the following surrounding areas which affect flows through the basin: the Loxahatchee Slough, the Lake Worth Lagoon, Lake Okeechobee, the Grassy Waters Preserve, Water Conservation Area 1 (WCA-1), Stormwater Treatment Area (STA) 1 East, and the C-51 Canal. It is the intent of the GRR to select a plan that will have the operational capability and flexibility to aid in restoration of the ecological integrity of the J.W. Corbett Wildlife Management Area, DuPuis Reserve, Loxahatchee Slough and the Northwest Fork of the Loxahatchee River; reduce impacts to the Lake Worth Lagoon; and improve flood protection in the L-8 Basin.

The first phase of the GRR has been completed and is the result of a cooperative agreement among the SFWMD, Palm Beach County, City of West Palm Beach, and the Indian Trail Improvement District (ITID). The USACE agreed to allow the partners to expedite the Phase 1 portion of the GRR, at a cost to the local partners of approximately \$110,000, to identify existing problems, objectives, and preliminary alternatives to address problems in the L-8 Basin. Nine alternatives were identified based upon various combinations of 26 management measures. These will be further evaluated in Phase 2 and culminate in recommendations on the three best alternatives.

Phase 2 will be funded by the USACE and includes hydraulic and hydrologic modeling of existing conditions and an economic analysis of the nine alternatives identified in Phase 1. This work is scheduled to be completed in Fiscal Year (FY) 2002. Phase 3 will include screening and evaluating of the best three alternatives from Phase 2 and proposal of a "Recommended Plan." Phase 4 will include research and development of the EIS and preparation of the final GRR for Independent Technical Review (ITR) certification. The GRR is scheduled to be completed in 2004 following Phases 3 and 4 and ITR certification. The timeline for the design and construction of the recommended alternative will be determined upon completion of the GRR.

S-155A Structure

The C-51 Canal serves a basin that extends from WCA-1 east to Lake Worth Lagoon in central Palm Beach County. The C-51 Basin includes the cities of West Palm Beach, Lake Clarke Shores, Wellington, Royal Palm and large areas of central Palm Beach County. The C-51 Canal was constructed to remove excess waters and provide flood protection from 1-in-8 year to 1-in-10 year rainfall conditions in the eastern basin, and to provide protection in the west portion of the basin for less than a 1-in-5 year event. Currently, urban and agricultural areas in the western basin are flooded by storms every two to three years.

Major modifications to the western C-51 Canal have been designed and are under construction. Construction of a new water control structure, S-155A which can act as a drainage divide structure, has been recently started. The control elevation in the C-51 Canal west of S-155A will be raised to conserve water resources by preventing overdrainage. Freshwater discharges through the eastern C-51 Canal and S-155 will be reduced, which will improve water quality in Lake Worth Lagoon. Two other major projects, STA 1 East and the pump station (S-319) that discharges runoff into this treatment area from the C-51 Canal Basin, are also under construction.

These modifications will provide improved flood protection and environmental benefit. When all the facilities are constructed and operational, flood elevations and duration in the western C-51 Basin will be significantly reduced and increased storage will be available for water quality improvement and environmental enhancement. Stormwater runoff will be captured and stored for future use.

C-17 Basin Flood Control Study

The C-17 Basin has a drainage area of approximately 33 square miles (21,200 acres) and is located in northeastern Palm Beach County. The canal and its control structure, S-44, were designed to provide flood protection and drainage for the basin and to maintain a groundwater table elevation in the area to prevent saltwater intrusion. In 1955, the USACE completed the General Design Memorandums (GDMs) for the canal and structure. At that time, most of the land was in unimproved pasture or in agricultural production.

Today, the population within the C-17 Basin exceeds 68,000 people. Given the growth that has taken place and the significant changes in land use, from primarily agricultural to predominantly urban, it is appropriate to evaluate the level of flood protection. In recent years, storm events have generated runoff in excess of the original design discharge and urban areas in the C-17 Basin have experienced flooding.

Therefore, a study is underway by the Northern Palm Beach County Improvement District, in partnership with SFWMD, to investigate the existing conditions within the C-17 Basin, including hydraulic facilities and environmental conditions, and to develop hydrological and hydraulic computer models for this basin. The study began in 2000 and will be completed in 2002.

Cypress Creek/Pal-Mar and the Groves Basin Study

Cypress Creek/Pal-Mar and the Groves are two of the seven subbasins in the Loxahatchee River Watershed. These two basins occupy approximately 63 square miles (40,500 acres) in Martin and Palm Beach Counties. Within the two basins, Cypress Creek and Hobe Groves Ditch are major sources of surface water to the Northwest Fork of the Loxahatchee River. The Cypress Creek/Pal-Mar Basin is made up of 86 percent native uplands and wetlands. A little over 10,000 acres of native uplands and wetlands are in public ownership in the Hungry Land Wildlife and Environmental Area. The majority of

runoff from this basin moves through overland flow from west to east then discharges into the Ranch Colony Canal and Cypress Creek. The eastern portion of the basin has been significantly altered to accommodate agricultural and residential land uses. Citrus groves are the predominant land use in the Groves Basin, which is drained by the Hobe Groves Ditch and the Federation Canal.

The SFWMD, Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Environmental Protection (FDEP), and Martin County have teamed together, using SFWMD funds, to initiate a study of these areas. The following water resource related problems have been identified:

1. Upstream movement of salt water in the Northwest Fork of the Loxahatchee River
2. Sediment loading in Cypress Creek and the Loxahatchee River
3. Flooding in Ranch Colony during severe storms
4. Overdrainage in the Pal-Mar wetlands

A set of models that represent the hydrologic and hydraulic processes in the Cypress Creek/Pal-Mar and the Groves basins will be developed. The models will provide a basis for solutions to the current problems of the area, such as, to optimize wetland management on the Pal-Mar property and to identify and manage discharge volumes from the Groves and from Cypress Creek to the Northwest Fork of the Loxahatchee River.

PROJECTS INITIATED BY OTHER GOVERNMENT ENTITIES

Table 6 includes a partial listing of projects and activities within or near the planning area that have been initiated by other agencies or local governments. A number of these projects are being sponsored by The Loxahatchee River Preservation Initiative to receive legislative appropriations for funding in 2002. All of these projects and efforts will need to consider the analyses, conclusions and recommendations in this NPBCCWMP as they move forward. Results of these efforts may also be incorporated into, or considered in, future revisions of the LECRWSP.

Hungryland Slough

The SFWMD, through the Save Our Rivers Program, owns 1,425 acres in Loxahatchee Slough, located immediately west of the property owned by Palm Beach County, south of C-18 Canal and east of Calusa. A significant hydrologic restoration project is underway on this property to plug old agricultural ditches and allow water to flow east as sheetflow across the county property to the C-18 East Canal. Presently, this water drains north into the west leg of the C-18 Canal. If the water can be moved to the east, more water will be available for storage within the Loxahatchee Slough.

Table 6. Northern Palm Beach County Area Projects Primarily Initiated by Other Governmental Agencies.

| Project | Year Initiated | Lead Agency and Funding Partners | Estimated Total Project Cost (dollars) |
|--|-----------------------|--|---|
| C-18 Culvert Connections to Hungryland Slough (removal and replacement of existing culverts) | FY 02 | Palm Beach County, SFWMD | 70,000 |
| Central Western Communities Sector Plan | FY 01 | Palm Beach County | |
| Kitching Creek Comprehensive Basin Study* | FY 95 | Martin County | NA** |
| Loxahatchee Slough Hydrologic Model and Master Plan Development* | FY 01 | Palm Beach County | NA** |
| Jonathan Dickinson State Park Water Quality Improvements* | FY 02 | Jonathan Dickinson State Park and others | 750,000 |
| Jones Creek Restoration* | FY 02 | Town of Jupiter | 2,000,000 |
| Riverbend Park Hydrologic Restoration* | FY 02 | Palm Beach County and SFWMD | 750,000 |
| Hell's Canal Hydrologic Restoration* | | Jonathan Dickinson State Park (Florida Department of Environmental Protection) | NA** |
| Jupiter Farms Water Quality Improvements* | | South Indian River Water Control District | |

*Projects proposed by the Loxahatchee River Preservation Initiative; ** Not Available.

Riverbend Park

Several years ago the SFWMD purchased the Reese and Gildan properties for inclusion in the Loxahatchee River corridor. Through an agreement with the SFWMD, the Palm Beach County Parks and Recreation Department is managing the properties as part of Riverbend Park. Together, the SFWMD and Palm Beach County are implementing a plan to reestablish and maintain some remnant sloughs that were tributary to the Northwest Fork of the Loxahatchee River. County staff will complete the Riverbend Park slough restoration in FY 2002. In addition, SFWMD staff have completed the installation of three 60-inch diameter culverts with operable gates in the C-18 Canal. These improvements will allow water to be diverted through Riverbend Park to maintain the restored slough system and provide additional flowpaths, increase storage, and increase flows to the Northwest Fork of the Loxahatchee River.

South Indian River Water Control District (SIRWCD)

In 1989, the SFWMD and the South Indian River Water Control District (SIRWCD) entered into an agreement to share the costs of installation of system improvements to the SIRWCD system not to exceed \$750,000. The improvements involve the installation of a 100-cfs pump at the southern perimeter of SIRWCD lateral canal #7. Lateral canal improvements are planned and are in the design stage.

Construction of the pump station is contingent upon water quality concerns being addressed. A stormwater treatment area (STA)/reservoir may need to be located internal to the SIRWCD system or adjacent to the SIRWCD.

However, lateral canal improvement design is progressing and installation may take place in FY 2003. The lateral canal improvements will allow more water to be held in the SIRWCD system during dry periods.

SUMMARY

All interests in this area must continue to work together to achieve the goals of this plan and meet the future water supply needs of northern Palm Beach County. The ultimate success of this plan will depend upon the ability to effectively coordinate among federal, state, regional and local efforts in a timely manner to meet the projected future needs of this planning area during the next 20 years. The ability to implement these related projects is especially important because they provide the links and supplemental sources that allow local interests to take full advantage of additional water that is being developed in regional storage through construction of CERP and LECRWSP projects. A list of projects mentioned in this plan and associated timelines are provided in **Figure 5**.

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|--|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Northern Palm Beach County Comprehensive Water Management Plan - Studies and Projects | | | | | | | | | | | | | | | | | | | | | |
| M Canal Widening | | | | | | | | | | | | | | | | | | | | | |
| G-160 Loxahatchee Slough Structure | | | | | | | | | | | | | | | | | | | | | |
| ASR Wellfield Feasibility and Siting | | | | | | | | | | | | | | | | | | | | | |
| Pilot Study | | | | | | | | | | | | | | | | | | | | | |
| L-8 Pilot Water Storage | | | | | | | | | | | | | | | | | | | | | |
| L-8 Reservoir Testing | | | | | | | | | | | | | | | | | | | | | |
| L-8 (Control 2) Pump Station Diversion - Siting Study | | | | | | | | | | | | | | | | | | | | | |
| Design and Construction | | | | | | | | | | | | | | | | | | | | | |
| G-161 Flow-way Improvements - Planning | | | | | | | | | | | | | | | | | | | | | |
| Design and Construction | | | | | | | | | | | | | | | | | | | | | |
| WPB Wetlands-Based Water Reclamation Project | | | | | | | | | | | | | | | | | | | | | |
| Comprehensive Everglades Restoration Plan - Studies and Projects | | | | | | | | | | | | | | | | | | | | | |
| North Palm Beach County Project - Part 1 | | | | | | | | | | | | | | | | | | | | | |
| Project Management Plan for Part 1 | | | | | | | | | | | | | | | | | | | | | |
| Project Implementation Report for Part 1 | | | | | | | | | | | | | | | | | | | | | |
| Pal Mar & Corbett WMA Hydroperiod Restoration | | | | | | | | | | | | | | | | | | | | | |
| L-8 Basin Modifications | | | | | | | | | | | | | | | | | | | | | |
| C-51 & Southern L-8 Reservoir | | | | | | | | | | | | | | | | | | | | | |
| L-8 Reservoir Testing Project* | | | | | | | | | | | | | | | | | | | | | |
| Lake Worth Lagoon Restoration | | | | | | | | | | | | | | | | | | | | | |
| C-17 Backpumping & Treatment | | | | | | | | | | | | | | | | | | | | | |
| C-51 Backpumping & Treatment | | | | | | | | | | | | | | | | | | | | | |
| North Palm Beach County Project - Part 2 | | | | | | | | | | | | | | | | | | | | | |
| Development of the Project Management Plan for Phase 2 | | | | | | | | | | | | | | | | | | | | | |
| Project Implementation Report for Phase 2 | | | | | | | | | | | | | | | | | | | | | |
| C-51 Regional Groundwater Aquifer Storage & Recovery Wells | | | | | | | | | | | | | | | | | | | | | |
| L-8 Basin Aquifer Storage & Recovery Wells | | | | | | | | | | | | | | | | | | | | | |
| Other Related SFWMD Projects | | | | | | | | | | | | | | | | | | | | | |
| Regional Reuse of Reclaimed Water -- Feasibility/Master Plan | | | | | | | | | | | | | | | | | | | | | |
| Design and Permitting | | | | | | | | | | | | | | | | | | | | | |
| Construction | | | | | | | | | | | | | | | | | | | | | |
| MFL Rule Development-- NW Fork of the Loxahatchee River | | | | | | | | | | | | | | | | | | | | | |
| L-8 GRR - Phase 1 Development of Alternatives (Report) | | | | | | | | | | | | | | | | | | | | | |
| Phase 2 Modeling Initial Screening of Alternatives | | | | | | | | | | | | | | | | | | | | | |
| Phase 3 Interim Screening of Alternatives | | | | | | | | | | | | | | | | | | | | | |
| Phase 4 Final GRR | | | | | | | | | | | | | | | | | | | | | |
| S-155A | | | | | | | | | | | | | | | | | | | | | |
| Cypress Creek/Pal-Mar and the Groves Basin Studies and Plan | | | | | | | | | | | | | | | | | | | | | |
| C-17 Flood Control Study - Phase 1 Model Development | | | | | | | | | | | | | | | | | | | | | |
| Phase 2 Model Application | | | | | | | | | | | | | | | | | | | | | |

*The schedule for this project has been accelerated with local funding. Costs will be subsequently reimbursed/credited by CERP

Figure 5. Proposed Schedules of Projects Discussed in the Northern Palm Beach County Comprehensive Water Management Plan.

Chapter 7 RECOMMENDATIONS

Recommendations from the Lower East Coast Regional Water Supply Plan (LECRWSP) are presented in **Table 7**. Recommendations derived from this plan are presented in **Table 8**.

Table 7. Recommendations from the Lower East Coast Regional Water Supply Plan.

| Recommendation | Recommendation Number |
|---|-----------------------|
| Northern Palm Beach County Comprehensive Water Management Plan. Develop a Northern Palm Beach County Comprehensive Water Management Plan to identify water management options for this area. | 3 |
| Floridan Aquifer System Ground Water Model. Refine the existing Floridan Aquifer System Ground Water Model using data collected from Aquifer Storage and Retrieval studies. | 2 |
| Permitting Issues Associated with Aquifer Storage and Retrieval Systems and Reuse of Reclaimed Water. Work in partnership with the Florida Department of Environmental Protection to explore and correct remaining inconsistencies and conflicts among the goals, objectives, and rules of the various programs involved in Aquifer Storage and Retrieval, wastewater and reuse of reclaimed water programs to maximize the reuse of reclaimed water and Aquifer Storage and Retrieval technologies. | 15 |
| S-155A. Conduct additional analysis in the design phase of the Comprehensive Everglades Restoration Plan to provide water to the C-51 backpumping and treatment component and provide benefits to Lake Worth Lagoon without affecting the location of S-155A. | 18 |
| L-8 Project. Develop an operating schedule that can optimize the use of the stored ASR water to meet EAA demands. | 21 |
| Systemwide Operational Protocols. develop a comprehensive set of revised operational protocols that affect the entire SFWMD area and includes the original components of the Central and Southern Florida Project, as well as supplemental project structures constructed by the SFWMD and the Everglades Construction Project. | 31 |
| Periodic Operational Flexibility. Develop a process to identify and implement short-term deviations to existing operational protocols that consider all of the existing and proposed components of the regional water management system. | 32 |
| Water Reservations. Establish Water Reservations where necessary to assure the public of the availability of water specific to locations for the protection of fish and wildlife or protection of public health and safety. | 34 |
| Comprehensive Water Conservation Program. Develop and implement a comprehensive water conservation program to cultivate a water conservation ethic in cooperation with water users, utilities, and local governments to promote more efficient use of the water resources in the Lower East Coast Planning Area. | 41 |
| Reclaimed Water System in Northern Palm Beach County. Examine the feasibility of meeting the unmet future demands for irrigation water in northern Palm Beach County and coastal Martin County by conveying reclaimed water from central Palm Beach County. | 43 |
| Indirect Aquifer Recharge. Explore the feasibility of recharging primary or secondary canals with wastewater treated to meet Advanced Wastewater Treatment standards in conjunction with a cooperative utility. | 44 |
| Water Supply Development. Individual water users should evaluate alternative water supply sources and select the alternative, or combination of alternatives, which best suits local conditions. The SFWMD will continue to evaluate consumptive uses for their impacts on both the regional system and local resources on a case-by-case basis. | 46 |

Table 8. Recommendations Derived from This Plan.

| General Recommendations | Major Plan Goals * Addressed |
|--|---|
| Increase storage and conveyance of surface water within and between the respective basins. | ws |
| Improve water quality through appropriate use of wetlands for water storage and treatment. | wq |
| Protect and enhance environmental resources by protecting and restoring hydrology of rivers and wetlands. | er |
| Provide additional water for urban and agricultural use. | ws |
| Optimize surface water management in the region for water supply, flood protection and ecosystem management purposes. | ws er fc |
| Develop formulas, operational protocols and agreements needed for facilities that will provide a more equitable balance between environmental and water supply benefits in Grassy Waters Preserve and Loxahatchee Slough. | ws er |
| Develop a comprehensive funding strategy to implement the recommendations in this plan. | All |
| Effectively coordinate projects identified in this plan with ongoing and future efforts by other agencies, counties, local governments and private interests. | All |
| Develop alternative water supplies, such as reclaimed water to reduce dependence on, and use of, regional water sources. | ws er |
| Specific Recommendations | |
| Construct 48,000 acre-feet of storage provided by a single or multiple reservoirs located in either the Southern L-8 Basin and/or the C-18 Basin. | ws fc |
| Continue to support the development and implementation of the L-8 General Reevaluation Report (L-8 GRR). | ws wq |
| Develop 50 mgd of aquifer storage and recovery (ASR) capacity. | ws |
| Increase the conveyance capacity of the M-Canal up to 450 cfs. | ws er |
| Construct a replacement for the West Palm Beach C-2 Structure with a capacity of 400 cfs. | ws |
| Implement an additional 10 mgd of reclaimed water reuse to meet current and future irrigation demands and environmental needs in the northern Palm Beach County area. | ws |
| Develop and implement a Regional Reclaimed Water Master Plan. | we |
| Provide up to 150 cfs of conveyance capacity from the Grassy Waters Preserve to the C-18 Canal Basin. | er |
| Construct a structure, G-161, in the form of a flowway/culvert system at Northlake Blvd. that will allow the conveyance of water from the Grassy Waters Preserve to the Loxahatchee Slough. | er |
| Backpump excess stormwater in the C-17 Canal Basin into a 550-acre STA, that will discharge to the Grassy Waters Preserve. | wq ws er |
| Construct G-160, the Loxahatchee Slough Structure, to provide precise discharge of in the 0-100 cfs range and coarser discharge up to 500 cfs. | er |
| Improve surface water management and conveyance to provide additional recharge to the Town of Jupiter wellfield to prevent saltwater intrusion. | ws wq |
| Reroute stormwater discharges from the Old Marsh and Eastpointe development into the Loxahatchee Slough, east of the C-128 Canal, to facilitate storage in the slough. The Mirasol development will receive the stormwater discharges from Old Marsh and Eastpoint, which will be routed through the Mirasol stormwater management system prior to conveyance to the slough. | ws er wq |
| Develop technical criteria and adopt a Minimum Flow and Level Rule and a Recovery and Prevention Strategy for the Loxahatchee River and Estuary. | er |
| Develop and implement reservations of water for the Northwest Fork of the Loxahatchee River. | er |

* ws=water supply; fc=flood control; wq=water quality; er=environmental resource management

WORKING DRAFT OF THE IMPLEMENTATION SCHEDULE

Phase 1 - One Year (April 2001 through March 2002)

Identify improvements that can be implemented within one year (by July 2002) to deliver 10 to 20 cubic feet per second (cfs) to the Northwest Fork of the Loxahatchee River during dry periods. The ability to provide water from the Grassy Waters Preserve to the Northwest Fork without significantly lowering the stage in the preserve is severely limited by the City's current pumping capacity from the L-8 Canal into the M-Canal (and subsequently into the preserve). Based on recent observations and depending on the severity of the dry conditions (normal dry season versus drought) the pumping capacity only exceeds demands by 10 to 20 cfs.

- Install new culverts under the entrance road into the Grassy Waters Preserve Southern Nature Center to reestablish this conveyance.
- Perform maintenance consisting of invasive removal, excavation and grading to clear out obstructions and allow approximately 20 cfs of flow from the eastern perimeter canal to the three western 72-inch diameter culverts under Northlake Boulevard.
- Evaluate the constraints imposed by ground surface elevations, existing roads, existing buildings, and existing control structures on the ability to route water from the north side of Northlake Boulevard (at the existing three 72-inch culverts and eastward) to the box culverts under the Bee Line Highway (State Road 710), which includes evaluating both the constraints and conditions of Control 5, the structure that controls flow of water from the north side of Northlake Boulevard to the east.
- Implement the L-8 Pilot Project, evaluate the results and determine future actions needed.
- Evaluate further improvements that may be needed as a result of increasing Loxahatchee Slough hydroperiods. These include evaluation of the integrity of the berms confining the slough (e.g., PGA Boulevard), potential drainage impacts caused by raising the tailwater level of the PGA's Preserve discharge weir, drainage at the Palm Beach Gardens Municipal Golf Course, and the retrofit of the existing dike at Old Marsh. South Florida Water Management District (SFWMD) staff are currently evaluating a transitional period of approximately 3-5 years to allow gradual changes in vegetation and refinement in operational criteria. During the first years of this transition, existing boards and berms may have to remain in place, to maintain higher water levels in the portion of the slough located west of the south leg of C-18

Canal, until the hydroperiod of the eastern portions of the slough reaches a similar level.

Phase 2 - Three Years (April 2001 through March 2004)

Implement the following improvements to improve the flow capacity for both dry and wet conditions:

- Construct Loxahatchee Slough Structure (G-160).
- Increase flow capacity from M-Canal to the three existing 72-inch culverts by removing biomass accumulation and establish canoe paths. These improvements will allow a total flow capacity of approximately 30 cfs.
- As required, modify existing structures to provide conveyance and water quality enhancement (north of Northlake Boulevard) including but not limited to the following:
 1. Modify or remove Control 5.
 2. Construct a spreader swale north of, and parallel to, Northlake Boulevard.
 3. Remove, breach, or construct culverts through berms or other obstructions.
 4. Construct an enhanced flowway and preferential flow path as needed to accommodate both dry and normal wet-weather flows and large stormwater flows without significant damage to the flowway area while maintaining the required level of drainage.
- Replace the Central and Southern Florida Project C-18 Basin Culvert 9 and others as required to facilitate both interim and long-term hydroperiod enhancement.
- Develop a project management plan (PMP) and project implementation report (PIR) for Part 1 components of the Comprehensive Everglades Restoration Plan (CERP), North Palm Beach County Project.
- Implement the PIR and prepare general design memorandums (GDMs) for Part 1 components of the North Palm Beach County Project.
- Conduct additional supplemental testing of the L-8 Pilot Reservoir, if necessary.

Phase 3 - Five Years (April 2001 through 2006)

Implement the following improvements to substantially increase subregional conveyance capacity and provide a backbone for the final water distribution system required by both the CERP and the LECRWSP:

- Construct the M-Canal Pump Station (C-2) and canal conveyance improvements.
- Install Northlake Boulevard culverts and gates (G-161) and enhanced flowway.
- Prepare CERP Design Documentation Memorandums (DDMs) for the following projects arising from the Northern Palm Beach County PIR:
 1. C-51 and Lake Worth Lagoon sediment removal
 2. L-8 and C-51 Reservoir or reservoirs
 3. Acquisition and restoration of 3,000 acres to enhance the hydroperiods and minimum flow to the Northwest Fork of the Loxahatchee River
 4. C-17 backpumping, including hydraulic improvements (e.g., pump stations and canal conveyance) and water quality treatment provided by a new stormwater treatment area (STA)
 5. C-51 backpumping, including hydraulic improvements (e.g., pump stations and canal conveyance) and water quality treatment provided by a new STA
 6. Other conveyance and water availability increasing improvements such as:
 - a. Installing a pump station to collect high quality runoff from the J.W. Corbett Wildlife Management Area, which is discharged to C-18 Canal, for storage in Loxahatchee Slough
 - b. Creating conveyance from the southeastern portions of the J.W. Corbett Wildlife Management Area to the west leg of the C-18 Canal
 - c. Improving conveyance to the perimeter canal of the Grassy Waters Preserve
 - d. Improving conveyance from the south of Northlake Boulevard to the C-18 Basin
 - e. Providing conveyance, structural (e.g., operational control gate for the lateral canals of Jupiter Farms) and operational changes

to improve water management capabilities in South Indian River Water Control District (SIRWCD) and Pal-Mar areas

Phase 4 - Comprehensive Everglades Restoration Plan (CERP) North Palm Beach County Project Part 1 (April 2001 to 2014)

Improvements to substantially increase subregional storage capacity and expand the water distribution system to meet the year 2050 needs:

- Remove sediments from C-51 and Lake Worth Lagoon.
- Construct L-8 and C-51 reservoir or reservoirs.
- Restore 3,000 acres to enhance hydroperiods and minimum flows to the Northwest Fork of the Loxahatchee River
- Construct C-17 backpumping system and STA.
- Construct C-51 backpumping system and STA.
- Construct conveyance and increased water availability improvements such as the following:
 1. A pump station to collect surplus high quality runoff from the J.W. Corbett Wildlife Management Area, which is discharged into the C-18 Canal, for storage in the Loxahatchee Slough
 2. Conveyance from the southeastern portions of the J.W. Corbett Wildlife Management Area to the west leg of the C-18 Canal
 3. Conveyance improvements to the perimeter canal of the Grassy Waters Preserve
 4. Conveyance improvement from south of Northlake Boulevard to the C-18 Basin
 5. Conveyance and operational changes to improve water management capabilities in the SIRWCD and Pal-Mar areas

Phase 5 - Comprehensive Everglades Restoration Plan (CERP) North Palm Beach County Project Part 2 (April 2001 to 2014)

- Implement PMP, PIR, and GDM for C-51 and L-8 Basin aquifer storage and recovery (ASR) (Year 2005 through 2010).
- Prepare a DDM for construction of C-51 and L-8 Basin ASR (2010 through 2012).
- Construct C-51 and L-8 Basin ASR facilities (2012 through 2020).

GLOSSARY

1995 Base Case A model simulation which provides an understanding of the how the 1995 water management system with 1995 land use and demands responds to historic (1965-1995) climatic conditions.

1-in-10 Year Drought A drought of such intensity, that it is expected to have a return frequency of once in 10 years. A drought in which below normal rainfall, which has a 90 percent probability of being exceeded over a twelve-month period. This means that there is only a 10 percent chance that less than this amount of rain will fall in any given year.

1-in-10 Year Level of Certainty Probability that the needs for reasonable-beneficial uses of water will be fully met during a 1-in-10 year drought.

2020 Base Case A model simulation which provides information of how the 1995 water management system would respond to anticipated future operations and demands under historic (1965-1995) climatic conditions with currently authorized restoration projects implemented, but without Restudy features.

2020 with Restudy A model simulation which provides information on how the water management system will perform with the implementation of the Restudy projects that would be completed by 2020 along with 2020 demands and operating criteria.

Acre-foot The volume would cover one acre to a depth of one foot; 43,560 cubic feet; 1,233.5 cubic meters; 325,872 gallons.

Agricultural Self-Supplied Water Demand The water used to irrigate crops, to water cattle, and for aquaculture (fish production), that is not supplied by a public water supply utility.

Aquifer A portion of a geologic formation or formations that yields water in sufficient quantities to be a supply source.

Aquifer Storage and Recovery (ASR) The injection of freshwater into a confined aquifer during times when supply exceeds demand (wet season), and recovering it during times when there is a supply deficit (dry season).

Aquifer System A heterogeneous body of intercalated permeable and less permeable material that acts as a water-yielding hydraulic unit of regional extent.

Available Supply The maximum amount of reliable water supply including surface water, ground water and purchases under secure contracts.

Average-day Demand A water system's average daily use based on total annual water production (total annual gallons or cubic feet divided by 365).

Average Irrigation Requirement Irrigation requirement under average rainfall as calculated by the District's modified Blaney-Criddle model.

Average Rainfall Year A year having rainfall with a 50 percent probability of being exceeded over a twelve-month period.

Backpumping The practice of pumping water that is leaving the area back into a surface water reservoir.

Basin (Ground Water) A hydrologic unit containing one large aquifer or several connecting and interconnecting aquifers.

Basin (Surface Water) A tract of land drained by a surface water body or its tributaries.

Best Management Practices (BMPs) Agricultural management activities designed to achieve an important goal, such as reducing farm runoff, or optimizing water use.

Biscayne Aquifer A portion of the Surficial Aquifer System, which provides most of the fresh water for public water supply and agriculture within Miami-Dade, Broward, and southeastern Palm Beach County. It is highly susceptible to contamination due to its high permeability and proximity to land surface in many locations.

Brackish Water with a chloride level greater than 250 mg/L and less than 19,000 mg/L.

C&SF Project Comprehensive Review Study (Restudy) A five-year study effort that looked at modifying the current C&SF Project to restore the greater Everglades and South Florida ecosystem while providing for the other water-related needs of the region. The study concluded with the Comprehensive Plan being presented to the congress on July 1, 1999. The recommendations made within the Restudy, that is, structural and operational modifications to the C&SF Project, are being further refined and will be implemented in the Comprehensive Everglades Restoration Plan (CERP).

Central and Southern Florida Project for Flood Control and Other Purposes (C&SF Project) A complete system of canals, storage areas, and water control structures spanning the area from Lake Okeechobee to both the east and west coasts, and from Orlando south to the Everglades designed and constructed during the 1950s by the U.S. Army Corps of Engineers (USACE) to provide flood control and improve navigation and recreation.

Commercial and Industrial Self-Supplied Water Demand Water used by commercial and industrial operations using over 0.1 mgd.

Comprehensive Everglades Restoration Plan (CERP) The recommendations made within the Restudy, that is, structural and operational modifications to the C&SF Project are being further refined and will be implemented through this plan.

Cone of Influence The area around a producing well which will be affected by its operation.

Control Structures A man-made structure designed to regulate the level and/or flow of water in a canal (e.g., weirs, dams).

Consumptive Use Use that reduces an amount of water in the source from which it is withdrawn.

Consumptive Use Permit A permit issued by the SFWMD allowing utilities to withdraw ground water for consumptive use.

Demand The quantity of water needed to be withdrawn to fulfill a requirement.

Desalination A process which treats saline water to remove chlorides and dissolved solids.

Domestic Use Use of water for the individual personal household purposes of drinking, bathing, cooking, or sanitation.

Drawdown The distance the water level is lowered, due to a withdraw at a given point.

District Water Management Plan (DWMP) Regional water resource plan developed by the District under Section 373.036, F.S.

Districtwide Water Supply Assessment (DWSA) This document includes water demand assessments and projections, and descriptions of the surface water and ground water resources within each of the SFWMD's four planning areas.

Domestic Self-Supplied Water Demand The water used by households whose primary source of water is private wells and water treatment facilities with pumpages of less than 0.5 mgd.

Domestic Use Use of water for the individual personal household purposes of drinking, bathing, cooking, or sanitation.

Drawdown The drawdown at a given point is the distance the water level is dropped.

Estuary A water passage where the ocean or sea meets a river.

Evapotranspiration Water losses from the surface of soils (evaporation) and plants (transpiration).

Everglades Agricultural Area (EAA) The area of histosols (muck) predominantly to the Southeast of Lake Okeechobee which is used for agricultural production.

Everglades Construction Project The foundation for the largest ecosystem restoration program in the history of Florida. It is composed of 12 interrelated construction projects located between Lake Okeechobee and the Everglades, including over 47,000 acres of Stormwater Treatment Areas (STAs).

Exotic Nuisance Plant Species A non-native species which tends to out-compete native species and becomes quickly established, especially in areas of disturbance or where the normal hydroperiod has been altered.

Florida Department of Agricultural and Consumer Services (FDACS) FDACS communicates the needs of the agricultural industry to the Legislature, the FDEP, and the water management districts, and ensures participation of agriculture in the development and implementation of water policy decisions. FDACS also oversees Florida's soil and water conservation districts, which coordinate closely with the federal Natural Resources Conservation Service (NRCS).

Florida Department of Environmental Protection (FDEP) The District operates under the general supervisory authority of the FDEP which includes budgetary oversight.

Floridan Aquifer System (FAS) A multiple-use aquifer system composed of the upper Floridan and lower Floridan aquifers. It is the principal source of water supply north of Lake Okeechobee and the upper Floridan aquifer is used for drinking water supply in parts of Martin and St. Lucie counties. From Jupiter to south Miami, water from the Floridan Aquifer System is mineralized (total dissolved solids are greater than 1,000 mg/L) along coastal areas and in southern Florida.

Flatwoods (Pine) Natural communities that occur on level land and are characterized by a dominant overstory of slash pine. Depending upon soil drainage characteristics and position in the landscape, pine flatwoods habitats can exhibit xeric to moderately wet conditions.

Florida Water Plan State-level water resource plan developed by the FDEP under Section 373.036, F.S.

F.S. Florida Statutes.

FY Fiscal Year; the District's fiscal year begins on October 1 and ends on September 30 the following year.

Ground Water Water beneath the surface of the ground, whether or not flowing through known and definite channels.

Ground Water Heads Elevation of water table.

Harm *(Term will be defined during proposed Rule Development process)* An adverse impact to water resources or the environment that is generally temporary and short-lived, especially when the recovery from the adverse impact is possible within a period of time

of several months to several years, or less. Water shortage declarations are used to manage and mitigate such adverse impacts.

Hydropattern The pattern of inundation or saturation of an ecosystem.

Hydroperiod The frequency and duration of inundation or saturation of an ecosystem. In the context of characterizing wetlands, the term hydroperiod describes that length of time during the year that the substrate is either saturated or covered with water.

Incremental Simulations Model simulations performed to understand how the system would perform with partial completion of the Restudy projects and if the ability to meet the 1-in-10 year level of certainty criteria improves over time.

Indicator Region A grouping of model grid cells within the SFWMM consisting of similar vegetation cover and soil type. By grouping cells, the uncertainty of evaluating results from a single two by two, square mile grid cell that represents a single water management gage is reduced.

Infiltration The movement of water through the soil surface into the soil under the forces of gravity and capillarity.

Inorganic Relating to or composed of chemical compounds other than plant or animal origin.

Irrigation The application of water to crops, and other plants by artificial means.

Irrigation Efficiency The average percent of total water pumped or delivered for use that is delivered to the root zone of a plant.

Kriging A technique for interpolating nonstationary spatial phenomena which can be applied to such diverse hydrologic problems as interpolation of piezometric heads and transmissivities estimated from hydrogeologic surveys and estimation of mean areal precipitation accumulations. It can also be used in hydrologic network design because of its ability to estimate streamflow values using existing stations (Lo, 1992).

Lake Okeechobee Largest freshwater lake in Florida. Located in Central Florida, the lake measures 730 square miles and is the second largest freshwater lake wholly within the United States.

Leakance Movement of water between aquifers or aquifer systems.

Leak Detection Systematic method to survey the distribution system and pinpoint the exact locations of hidden underground leaks.

Levee An embankment to prevent flooding, or a continuous dike or ridge for confining the irrigation areas of land to be flooded.

Level of Certainty Probability that the demands for reasonable-beneficial uses of water will be fully met for a specified period of time (generally taken to be one year) and for a specified condition of water availability, (generally taken to be a drought event of a specified return frequency). For the purpose of preparing regional water supply plans, the goal associated with identifying the water supply demands of existing and future reasonable beneficial uses is based upon meeting those demands for a drought event with a 1-in-10 year return frequency.

Marsh A frequently or continually inundated wetland characterized by emergent herbaceous vegetation adapted to saturated soil conditions.

MODFLOW A fine-scale model code created by the U.S. Geological Survey. The District uses it for subregional and ground water modeling.

NGVD National Geodetic Vertical Datum, a nationally established references for elevation data relative to sea level.

NRCS The Natural Resources Conservation Service is a federal agency that provides technical assistance for soil and water conservation, natural resource surveys, and community resource protection

One-in-Ten Year Drought Event A drought of such intensity, that it is expected to have a return frequency of 10 years (see Level of Certainty).

Organics Being composed of or containing matter of, plant and animal origin.

Overhead Sprinkler Irrigation A pressurized system, where water is applied through a variety of outlet sprinkler heads or nozzles. Pressure is used to spread water droplets above the crop canopy to simulate rainfall.

Per Capita Use Total use divided by the total population served.

Permeability Defines the ability of a rock or sediment to transmit fluid.

Point Source Any discernible, confined and discrete conveyance from which pollutants are or may be discharged, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

Potable Water Water that is safe for human consumption.

Potentiometric Head The level to which water will rise when a well is pierced in a confined aquifer.

Potentiometric Surface An imaginary surface representing the total head of ground water.

Process Water Water used for nonpotable industrial usage, e.g., mixing cement.

Projection Period The period over which projections are made. In the case of this document, the 25 year period from 1995 to 2020.

Public Water Supply Demand All potable water supplied by regional water treatment facilities with pumpage of 0.5 million gallons per day (mgd) or more to all customers, not just residential.

Public Water Supply (PWS) Utilities Utilities that provide potable water for public use.

Rationing Mandatory water-use restrictions sometimes used under drought or other emergency conditions.

Reasonable-Beneficial Use Use of water in such quantity as is necessary for economic and efficient utilization for a purpose and in a manner which is both reasonable and consistent with the public interest.

Reclaimed Water Water that has received at least secondary treatment and basic disinfection and is reused after flowing out of a domestic wastewater treatment facility.

RECOVER A comprehensive monitoring and adaptive assessment program formed to perform the following for the Comprehensive Everglades Restoration Program: REstoration, COordination, and VERification.

Recreational Self-Supplied Water Demand The water used for landscape and golf course irrigation. The landscape subcategory includes water used for parks, cemeteries, and other irrigation applications greater than 0.1 mgd. The golf course subcategory includes those operations not supplied by a public water supply or regional reuse facility.

Reduced Threshold Areas (RTAs) Areas established by the District for which the threshold separating a General Permit from an Individual Permit has been lowered from the maximum limit of 100,000 GPD to 20,000 GPD. These areas are typically resource-depleted areas where there have been an established history of substandard water quality, saline water movement into ground or surface water bodies, or the lack of water availability to meet projected needs of a region.

Regional Water Supply Plan Detailed water supply plan developed by the District under Ch. 373.0361, F.S.

Reservoir A man-made or natural lake where water is stored.

Restudy Shortened name for C&SF Restudy.

Retrofit The replacement of existing equipment with equipment that uses less water.

Retrofitting The replacement of existing water fixtures, appliances and devices with more efficient fixtures, appliances and devices for the purpose of water conservation.

Reuse The deliberate application of water that has received at least secondary treatment, in compliance with the Florida Department of Environmental Protection and water management district rules, for a beneficial purpose.

Reverse Osmosis (RO) Common process used to produce deionized water from municipal water.

Saline Water Water with a chloride concentration greater than 250 mg/L, but less than 19,000 mg/L.

Saline Water Interface The hypothetical surface of chloride concentration between fresh water and saline water, where the chloride concentration is 250 mg/L at each point on the surface.

Saline Water Intrusion This occurs when more dense saline water moves laterally inland from the coast, or moves vertically upward, to replace fresher water in an aquifer.

Sea Water Water which has a chloride concentration equal to or greater than 19,000 mg/L.

Semi-Confining Layers Layers with little or no horizontal flow that can store ground water and also transmit it slowly from one aquifer to another. The rate of vertical flow is dependent on the head differential between the semi-confining beds and those above and below them, as well as the vertical permeability of the sediments.

Sensitivity Analysis An analysis of alternative results based on variations in assumptions (a “what if” analysis).

Serious Harm (*Term will be defined during proposed Rule Development process*) An extremely adverse impact to water resources or the environment that is either permanent or very long-term in duration. Serious harm is generally considered to be more intense than significant harm.

Seepage Irrigation Systems Irrigation systems which convey water through open ditches. Water is either applied to the soil surface (possibly in furrows) and held for a period of time to allow infiltration, or is applied to the soil subsurface by raising the water table to wet the root zone.

Significant Harm (*Term will be defined during proposed Rule Development process*) An adverse impact to water resources or the environment, relating to an established minimum flow or level for a water body; generally temporary but not necessarily short-lived, especially when the period of recovery from the adverse impact exceeds several months to several years in duration; more intense than harm, but less intense than serious harm.

Slough A channel in which water moves sluggishly, or a place of deep muck, mud or mire. Sloughs are wetland habitats that serve as channels for water draining off surrounding uplands and/or wetlands.

South Florida Water Management Model (SFWMM) An integrated surface water-ground water model that simulates the hydrology and associated water management schemes in the majority of South Florida using climatic data from January 1, 1965, through December 31, 1995. The model simulates the major components of the hydrologic cycle and the current and numerous proposed water management control structures and associated operating rules. It also simulates current and proposed water shortage policies for the different subregions in the system.

Stage The elevation of the surface of a surface water body.

Standard Project Flood (SPF) A mathematically derived set of hydrologic conditions for a region that defines the water levels that can be expected to occur in a basin during an extreme rainfall event, taking into account all pertinent conditions of location, meteorology, hydrology, and topography.

Storm Water Surface water resulting from rainfall that does not percolate into the ground or evaporate.

Stormwater Treatment Area (STA) A system of large treatment wetlands that use naturally occurring biological processes to reduce the levels of phosphorus from agricultural runoff prior to it being released to the Everglades.

Subregional Ground Water Model A computer model that is used to simulate impacts on a smaller scale than the SFWMM, such as effects within public water supply service areas and impacts of individual wellfields.

Subsidence An example of subsidence is the lowering of the soil level caused by the shrinkage of organic layers. This shrinkage is due to biochemical oxidation.

Supply-Side Management The conservation of water in Lake Okeechobee to ensure that water demands are met while reducing the risk of serious or significant harm to natural systems.

Surface Water Water that flows, falls, or collects above the surface of the earth.

Surficial Aquifer System (SAS) The SAS is the major source of water in the LEC Planning Area. It is unconfined, consisting of varying amounts of limestone and sediments that extend from the land surface to the top of an intermediate confining unit.

SWIM Plan Surface Water Improvement and Management Plan, prepared according to Ch. 373, F. S.

Transmissivity A term used to indicate the rate at which water can be transmitted through a unit width of aquifer under a unit hydraulic gradient. It is a function of the permeability and thickness of the aquifer, and is used to judge its production potential.

Uplands Elevated areas that are characterized by non-saturated soil conditions and support flatwood vegetation.

Wastewater The combination of liquid and waterborne discharges from residences, commercial buildings, industrial plants and institutions together with any ground water, surface runoff or leachate that may be present.

Water Budget An accounting of total water use or projected water use for a given location or activity.

Water Conservation Any beneficial reduction in water losses, wastes, or use.

Water Resource Development The formulation and implementation of regional water resource management strategies, including: the collection and evaluation of surface water and ground water data; structural and nonstructural programs to protect and manage the water resource; the development of regional water resource implementation programs; the construction, operation, and maintenance of major public works facilities to provide for flood control, surface and underground water storage, and ground water recharge augmentation; and, related technical assistance to local governments and to government-owned and privately owned water utilities.

Watershed The drainage area from which all surface water drains to a common receiving water body system.

Water Shortage Declaration *Rule 40E-21.231, Fla. Admin. Code:* "If ...there is a possibility that insufficient water will be available within a source class to meet the estimated present and anticipated user demands from that source, or to protect the water resource from serious harm, the Governing Board may declare a water shortage for the affected source class." Estimates of the percent reduction in demand required to match available supply is required and identifies which phase of drought restriction is implemented. A gradual progression in severity of restriction is implemented through increasing phases. Once declared, the District is required to notify permitted users by mail of the restrictions and to publish restrictions in area newspapers.

Water Supply Development The planning, design, construction, operation, and maintenance of public or private facilities for water collection, production, treatment, transmission, or distribution for sale, resale, or end use.

Water Supply Plan District plans that provide an evaluation of available water supply and projected demands, at the regional scale. The planning process projects future demand for 20 years and develops strategies to meet identified needs.

Wetlands Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

Weir A barrier placed in a stream to control the flow and cause it to fall over a crest. Weirs with known hydraulic characteristics are used to measure flow in open channels.

XeriscapeTM Landscaping that involves seven principles: proper planning and design; soil analysis and improvement; practical turf areas; appropriate plant selection; efficient irrigation; mulching; and appropriate maintenance.

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